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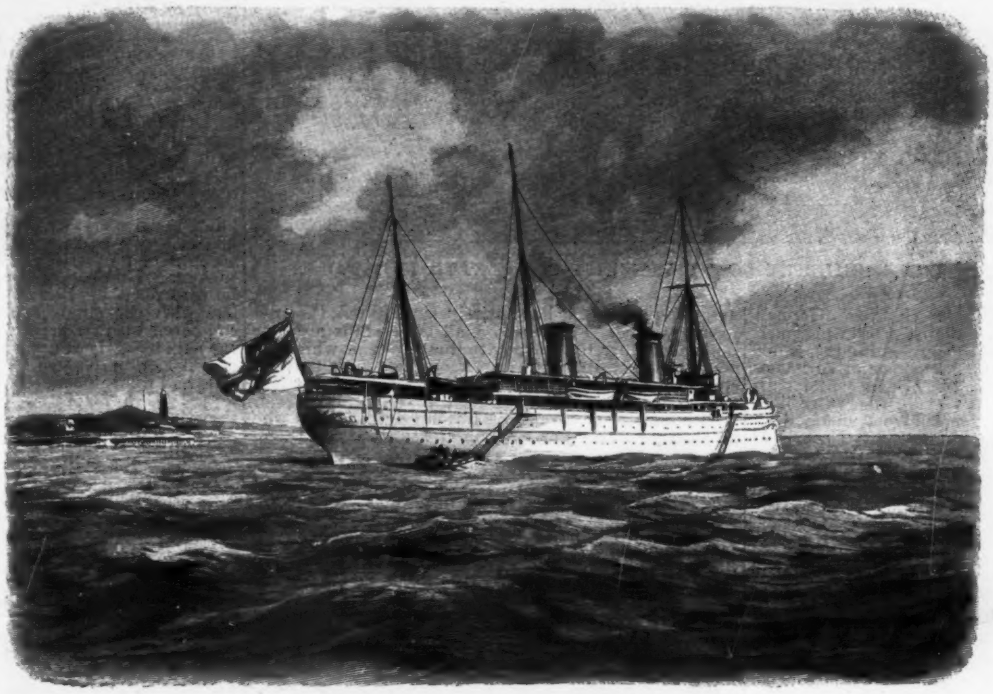
HOW A SHIP IS BUILT.

"Illi robur et aes triplex . . . . ," said Horace; but if the poet could have lived until our time, his opinion would have undergone a complete change, for a voyage across the ocean is far from being the unpleasant experience it seemed to him. On one of our modern passenger steamers, which are most appropriately called "floating palaces," one can cross from the old world to the new in less than six days, surrounded by all the comforts and luxuries of a great hotel, and be quite as safe as on a railroad train, to say the least. To be sure the human mind has required many centuries in which to develop the modern vessel from the frail craft of Horace's time, but during the last fifteen years great strides have been taken in this art, especially in Germany, where shipbuilders have found a powerful protector in Emperor Wilhelm II., who never allows an opportunity of favoring them to pass; so that now the German shipbuilders are in a position to compete with those of any other nation in the world, with the exception of England, which is rightly proud of the fame she has so long enjoyed. Vessels belonging to Germany's merchant marine, protected by her fine navy, traverse all the oceans of the globe, bent on their mission of obtaining a true appreciation of German arts and industries in foreign lands; and the North German Lloyds, of Bremen, stands at the head of all such corporations in the world, by virtue of the number as well as the size of its ships.



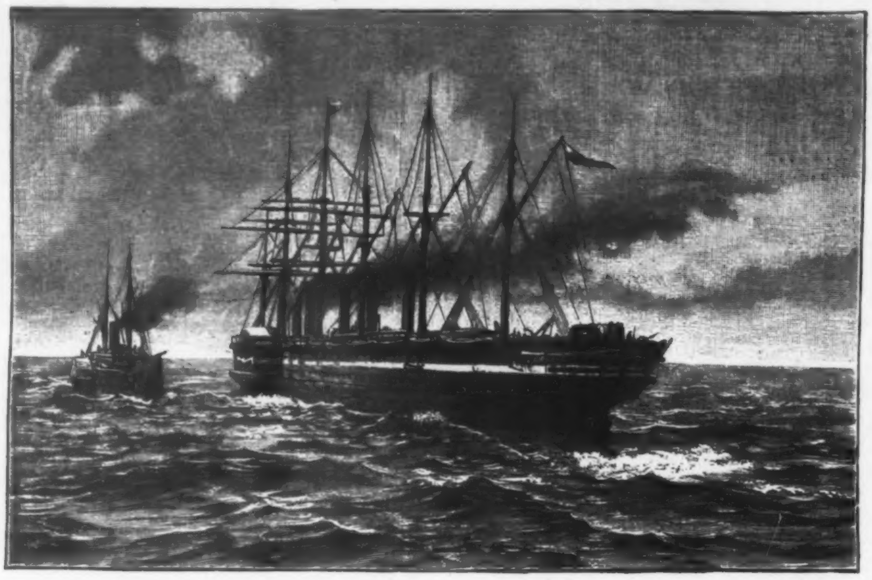
IMPERIAL YACHT "HOHENZOLLERN."

The international fast steamship lines have developed from small beginnings. In 1840 the first English transatlantic steamers made the trip from Bristol and Liverpool to New York in fifteen days, traveling at the rate of about eight miles an hour. They were wooden sidewheelers scarcely 230 feet long, strange ships not to be compared with the steamers of the present time in point of safety, speed or comfort; and yet the advent of these first transatlantic steamers marked a decided advance in the traffic of the world, for they were vastly superior to the old sailing vessels, which were entirely at the mercy of the wind. The first very large transatlantic steamer was built in England by Scott Russell; we refer to the famous and much-abused "Great Eastern," a vessel of gigantic dimensions. It was 679 feet long on the water line, had a displacement of 32,000 tons, and its engines, which indicated 7,650 horse power, gave it a trial speed of 14½ knots, a very respectable speed for those times. This great vessel existed far ahead of its time, for there was then so little demand for transportation that she could never secure the 4,000 passengers and 6,000 tons of cargo she was prepared to carry. For this reason she was a financial failure, but from a technical point of view she was a wonder, especially when we consider the primitive nature of the materials and the tools at the command of the constructors.

The German lines of fast steamers date from 1881, when the North German Lloyds made a beginning with the "Elbe," which was built in England and was the first fast steamer that carried the German flag at its stern. Five years later the German merchant marine included the "Elbe," "Aller," "Saale," "Trave" and "Lahn," all belonging to the North German Lloyds—five vessels capable of traveling 16 miles an hour, while England possessed only four that were equally fast. Since that time fast steamers have been built continuously. The Hamburg-American Packet Line, established in 1855, built, between 1889 and 1891, the "Augusta Victoria," "Columbia," "Normannia" and the "Fuerst Bismarck," four fine ocean greyhounds

SLIP FOR "KAISER WILHELM DER GROSSE"—LAYING KEEL.

which are fully equal to the vessels of the North German Lloyds. At present the merchant fleet of Germany consists of fifteen fast steamers, eleven of which belong to the North German Lloyds and four to the Packet Line. To-day the largest and fastest German steamer is the "Kaiser Wilhelm der Grosse," built at the Vulcan works, near Stettin, for the North German Lloyds. This colossal ship, which has been provided with all the improvements of modern technique, is not far behind the "Great Eastern" in size and surpasses all earlier vessels in speed and the elegance of its fittings. It has a length of 625 feet on the water line, breadth of beam of 66 feet, depth from shade deck to keel of 65 feet 7 inches, and a draught of nearly 28 feet. It has a capacity of 5,250 tons, and its engines of 27,000 horse power send it flying through the water at a rate of about 22 knots an hour. Five thousand tons of coal can be stored in its bunkers for heating the twelve 16-foot cylindrical boilers.



THE "GREAT EASTERN," BUILT BY SCOTT RUSSELL—COMPLETED IN 1859.

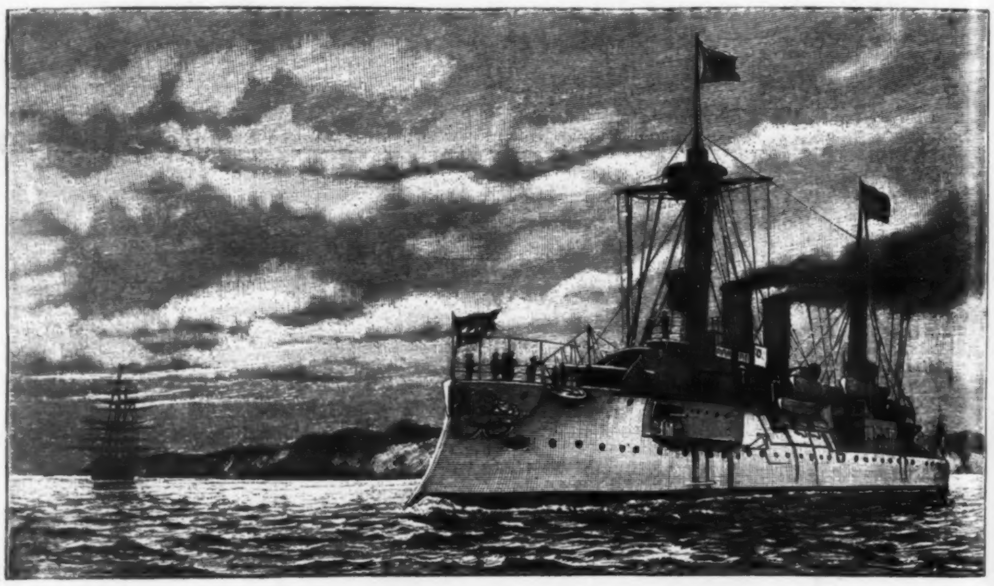
We will now consider the construction of such a giant of the sea. Our old naval and marine vessels were built without much study. If it happened that any part did not fit exactly, it could be trimmed off with an ax; but of course such methods can no longer be employed.

Shipbuilding has grown from a trade to a science, which is taught in schools of technology, and now careful drawings are made in accordance with scientific calculations for every vessel that is to be built. The main points to be considered in the construction of a fast steamer are speed, strength, safety, buoyancy, steadiness and comfort. To obtain a certain required speed for a ship of given dimensions, the first thing necessary is an engine of sufficient horse power, which would vary with the shape of the vessel. A vessel of considerable breadth of beam would, of course, require a stronger engine to give it a certain speed than a vessel of more slender build, because the latter would overcome the resistance of the water much more easily than the former. All this is determined by definite rules, which are not of general interest, but it may be stated that, where a high rate of speed is required, the lines of the fore, but more especially of the after, part of the vessel are kept as sharp as possible, for experiment has proved that even the most powerful engines cannot greatly increase the speed of a vessel that has great breadth of beam. They simply cause it to throw up mountainous waves in front of its bow. For this reason the lines of our modern steamers, cruisers and torpedo boats are kept very sharp, and thus great speed is obtained—in torpedo boats as much as 32 knots an hour—but at the same time, much space is lost which, especially in the case of merchantmen, is very valuable.

It is, of course, of the greatest importance that vessels traveling at such a rate of speed as that attained by our steamers in hurrying across the ocean should be provided with very solid frames. Theoretical calculations made from the frames of a number of old iron vessels showed that while the strength of the transverse frames was sufficient in all cases, the longitudinal frames left much to be desired, and therefore steel was substituted for iron, and has proved so satisfactory in every respect that it has entirely supplanted the iron formerly used. Furthermore, all large ships are now built according to the longitudinal system, which, in combination with the present keel, the double bottom, steel decks and stringer plates, gives the vessel great strength.

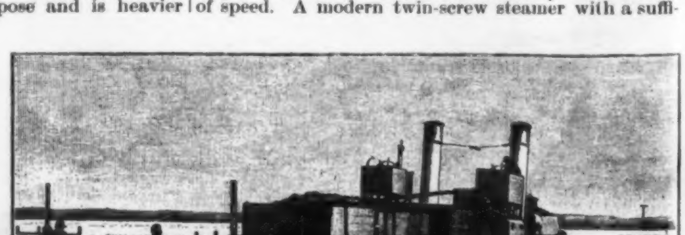
Although great strength is absolutely necessary, the greatest possible lightness is also a requisite, and therefore wooden masts have given way on large vessels to hollow steel ones, whereby a considerable amount of weight is saved. For the same reason the stem and stern posts are made of hollow cast steel; even the davits are hollow. This change in the construction of the smaller parts has effected in a single vessel a saving in weight of twenty tons. The two propeller shafts of the new North German Lloyds steamers are made of nickel steel instead of cast steel, which was formerly used for this purpose and is heavier than the nickel steel, but, on the other hand, it is less expensive. Although we believe our readers are interested in this matter of strength, instead of pursuing this subject further at present, we will turn to the equally interesting question of safety and try to show them how the new vessels have been made so much safer than their older sisters. In the first place, to prevent collisions—which are the cause of by far the greater part of the accidents to ships—and other injuries to its hull, a modern vessel is divided by watertight bulkheads into numerous watertight compartments. In unarmored war vessels there are often more than one hundred watertight compartments, a number of which could be flooded without causing the vessel to sink. The water in one of these compartments could be pumped out in a short time by means of the steam pumps and connecting pipes. There is always a main pipe connected by many branch pipes with the separate compartments and emptying into a collecting tank in the engine room, in which the pipes of all the steam pumps on board come together. If the outer shell of one of these compartments is injured so that water can enter it, all the other branch pipes are closed by automatic valves and then the collecting tank and the damaged compartment can soon be emptied by the pumps. Unarmored war vessels are provided with a belt of cork about six feet wide which runs entirely around the vessel, on the inside, near the water line. This belt not only gives the vessel greater buoyancy and acts as a protection from the guns of the enemy, but it will quickly stop a hole made by a shot, because of its well known property of swelling when wet—a fact that is demonstrated by every bottle cork that is drawn by a corkscrew.

Another source of safety in the new vessels is the twin screw system. There really was no guarantee of safety with the old wooden sidewheelers which once crossed the ocean, for there was so little solidity in the construction of those vessels that any heavy sea was liable to carry away not only the wheel, but the wheelhouse as well, and then, if the ship did not capsize on account of its loss of equilibrium, it drifted about on the ocean a helpless wreck, because it could no longer be controlled by the rudder. Even the older propellers with the single screw had many disadvantages compared with those provided with twin screws; for if the engine or the screw was badly injured, all thought of going on under steam had to be abandoned and the sails had to be depended upon in the attempt to make a port where the necessary repairs could be made, and sometimes the sails were so small and the superstructures so high and caught so much wind that very little headway could be made and hundreds of thousands of dollars had to be paid for having the vessel towed into port. On account of these disadvantages resulting from the use of the single screw, shipbuilders now almost universally employ the twin screws, each of which is driven by an entirely independent engine, so that if any accident renders one screw or one engine useless, the one still in good condition will enable the ship to reach its destination without any material loss of speed. A modern twin-screw steamer with a suffi-



BATTLESHIP "BRANDENBURG."

THE IMPERIAL MAIL STEAMER "QUEEN LUISE" AT THE DOCK OF THE VULCAN WORKS.



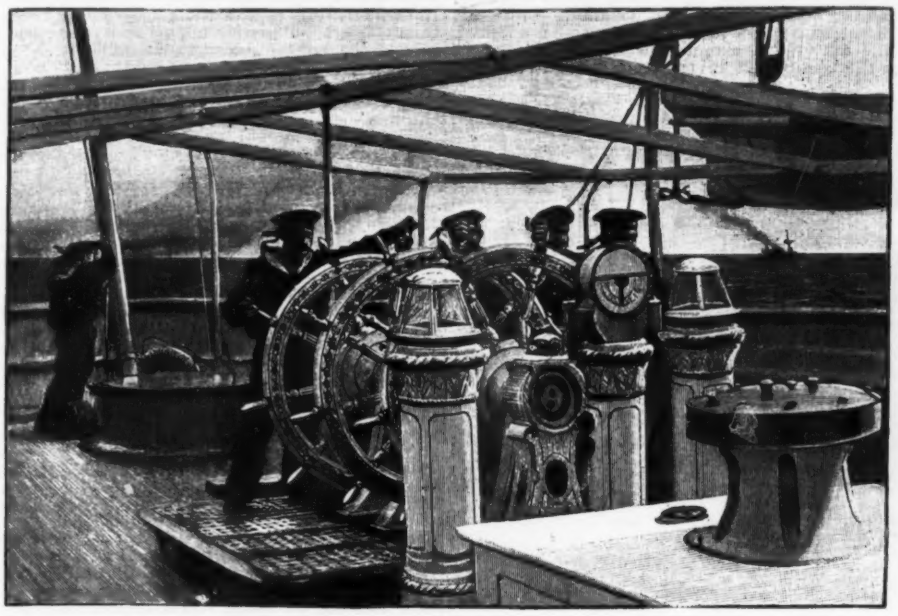
FERRYBOAT WITH COAL CARS FOR THE WORKS.

cient number of watertight compartments and strong framing is a very safe means of transportation even in the severest weather.

In building a ship great importance is attached to stability. By this we understand the ability of a vessel to withstand a heavy sea with the least possible interruption of its uniform motion—an end which may be reached by maintaining a proper proportion between the length, breadth and depth of the vessel, as well as by a suitable distribution of the heavy weights in the vessel. The modern ocean greyhounds have a length equal to about ten times the beam and a depth about half the beam. If a vessel were built too narrow and too shallow, it would be unstable and there would be danger of its capsizing in severe weather. If, on the other hand, a ship had too much stability, on account of great breadth of beam and great depth, it would be too stiff, and when thrown on its side by the sea and wind, it would right itself too quickly, in other words, it would roll badly. The motion in the direction of the long axis of the ship, the so-called pounding, which is more disagreeable to many passengers than the rolling motion, can also be greatly decreased by a proper construction of the vessel. The heavy weights, engines, boilers, cargo and coal should be placed in the middle of a vessel, only the light weights being put at the bow and stern. The double, twin screw system should also help to prevent the pounding motion.

The colossal proportions of a modern transatlantic steamer make it easy to obtain comfort, for only a comparatively small part of the available space is filled up by the engines, boilers, etc. The engine of a modern fast liner is somewhere about 40 feet high and about 50 feet long; it fills up the greater part of the width of the vessel and extends up through all the decks except the upper deck. The large ocean steamers have, as a rule, six or seven decks, viz., the bridge, the shade deck, the promenade deck, the upper deck, the main deck, the lower deck and the orlop deck. The upper, main and lower decks extend the entire length of the vessel, from stem to stern; the shade and promenade decks are about half as long as the ship and extend through the middle. Above the upper deck, forward, is the topgallant forecastle, while the poop deck or poop is aft; under the lower deck is the orlop deck, which is now utilized for the storage of materials, provisions, etc. The lower deck is the lowest one occupied by passengers, it being arranged for the third class or steerage passengers. On the old steamers the space between the lower deck and the main deck was often so low that a grown man could not stand upright, and then a voyage across the ocean in such dingy and badly ventilated quarters was not one of the most agreeable things in life; but on the modern ships the lower deck is from 8 feet 2 inches to 7 feet 4 inches high.

By mounting a flight of steps leading from the lower deck, the main or middle deck is reached, on which, in all new fast steamers, the finest saloon, the dining room for first-class passengers, is arranged, being placed well forward so as to be free from the steam and odors of the engine. On the fast English steamers "Lucania" and "Campania," of the Cunard line, this saloon is 111 feet 9 inches long by 65½ feet wide, while on the "Kaiser Wilhelm der Grosse" it is 114 feet 9 inches long and of the same width as that on the Cunard steamers. This saloon on the "Kaiser Wilhelm der Grosse" is a masterpiece of German workmanship. It is finished in the style of the early Italian Renaissance. The ground tone of the walls is light, with delicate gilding, and from the center of the richly decorated ceiling an enormous light shaft extends up to the shade deck, where it is closed by artistic colored glass. In the panels of the walls are paintings representing the residences of the emperors from early times to the present day. From the corners of this saloon open four smaller saloons which have been named for Queen Luise, Empress Augusta, Bismarck, and Moltke. Farther forward on this same deck are staterooms for passengers, and away forward accommodations for part of the crew. In the stern, on the middle deck, there is a saloon and also some staterooms for the second-class passengers.

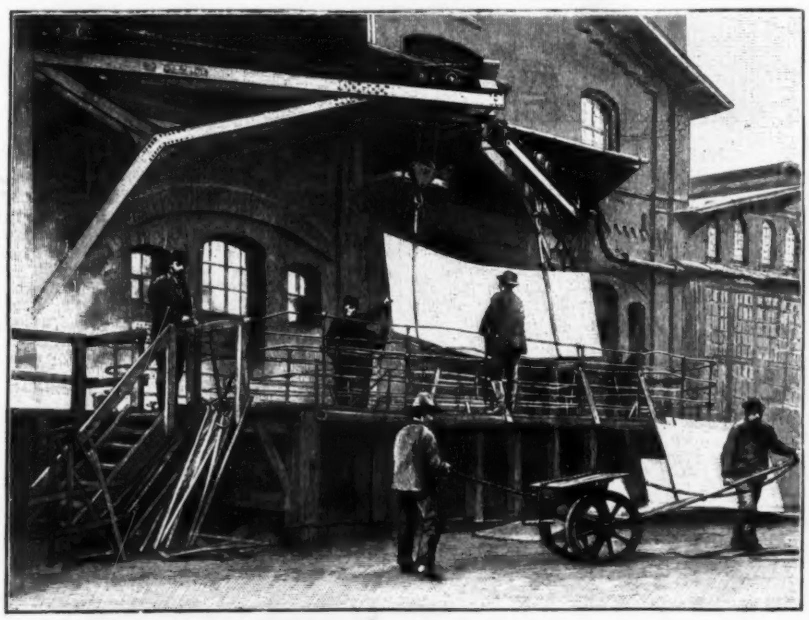


AT THE WHEEL—IMPERIAL YACHT "HOHENZOLLERN."

Another flight of stairs leads to the upper deck, which is devoted almost entirely to cabins or staterooms, there being only a small saloon and ladies' room for second-class passengers at the stern. There are cabins for first-class passengers forward; and in the bow is the hospital, the space forward of that being utilized for the crew.

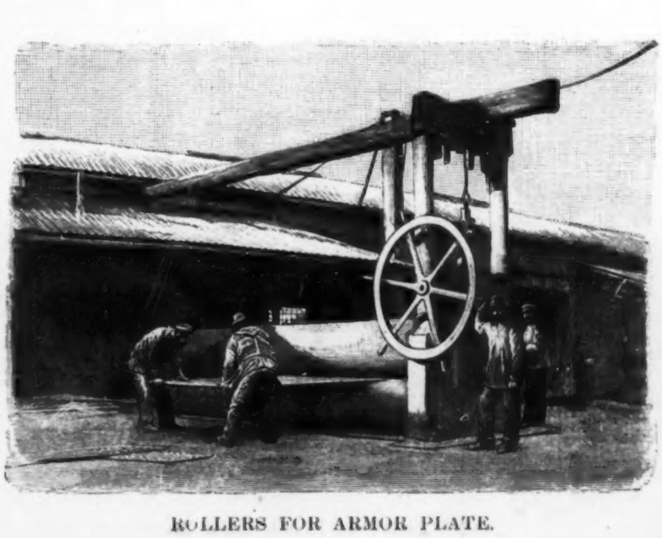
The next deck is the promenade deck, on which are arranged most of the social saloons, a smoking room for second-class passengers being at the stern, and forward there are some first-class cabins arranged in suits, each consisting of a sitting room, sleeping room and bath room. Although these are very expensive cabins, they are in great demand. Passengers are not allowed on the shade deck, which is reserved for officers and men on duty. And here are the spacious and elegantly fitted rooms of the captain, the cabins for the officers and the pilot, and also the wheel and chart rooms. The lifeboats are arranged on one side of the shade deck. On the "Kaiser Wilhelm der Grosse" there are twenty-four of these boats, which are always supplied with provisions, water, compass, oars and sails, so that in case of an emergency they can be launched immediately. Above the shade deck is the commander's bridge, where the telegraph for the engineers, the compass and the steering apparatus are arranged. One who has never seen a great ocean steamer can scarcely conceive of the degree of luxury and comfort afforded by them. Everything that can add to the comfort and pleasure of the passengers is provided. The new fast steamers are, of course, lighted by electricity and heated by steam, and steam is also used in cooking.

Our readers may be interested in knowing how the crew of a modern steamer is made up. On the "Kaiser Wilhelm" the crew consists of about 450 men, and includes 1 captain, 6 officers, 2 boatswains, 6 helmsmen, 3 carpenters, 42 sailors, 1 chief engineer, 13 engineers, 12 assistant engineers, 12 oilers and boys, 12 head



LOADING A STEEL PLATE.

SHEARS CUTTING STEEL PLATE.



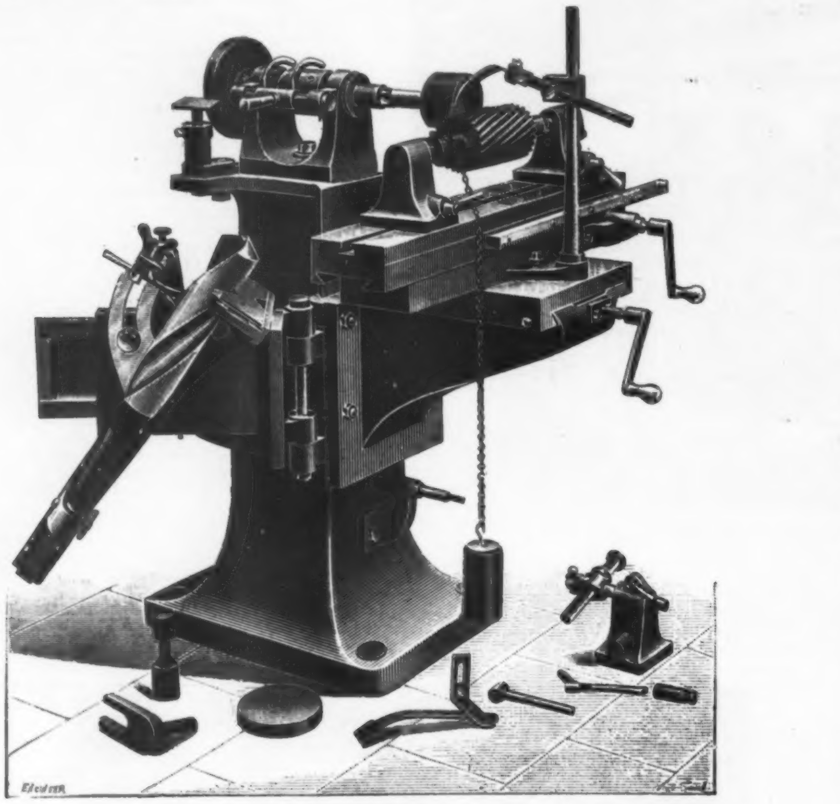
ROLLERS FOR ARMOR PLATE.

stokers, 170 stokers, 1 physician, 1 purser, 1 assistant purser, 1 barber, 1 chief cook, 8 cooks, 14 steam cooks and bakers, 2 confectioners, 2 butchers, 2 provision stewards, 2 chief stewards, 3 second stewards, 114 waiters, 12 scullions, 8 stewardesses, 3 electricians.

We are indebted to Ueber Land und Meer for the article and engravings.

MACHINE TOOLS.

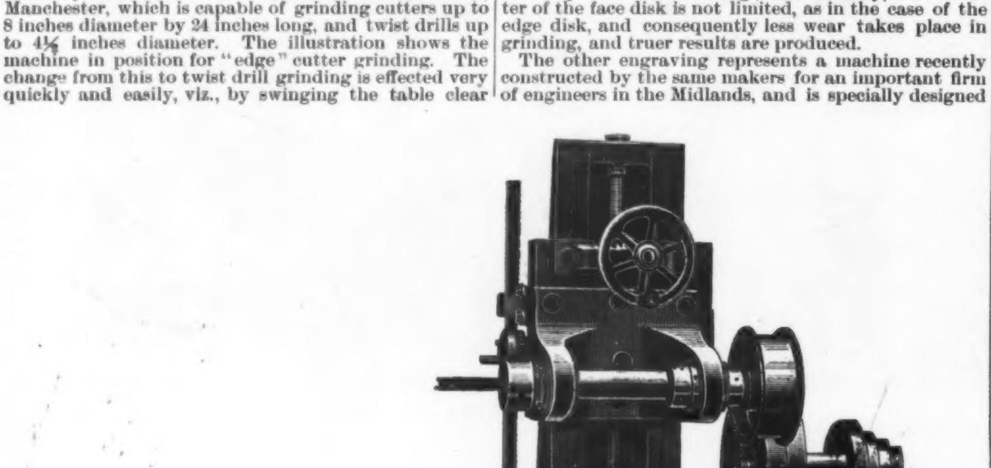
The annexed engraving illustrates a combined milling cutter and twist drill grinding machine recently made by Messrs. Hulse & Co., Ordsal Works, Salford, Manchester, which is capable of grinding cutters up to 8 inches diameter by 24 inches long, and twist drills up to 4½ inches diameter. The illustration shows the machine in position for "edge" cutter grinding. The change from this to twist drill grinding is effected very quickly and easily, viz., by swinging the table clear and bringing the twist drill grinding attachment into position. When grinding spiral cutters the requisite twist is given by means of a weight attached to the mandrel, which keeps the tooth of the cutter up against an adjustable guide. A universal headstock is provided for grinding face cutters, and the table has swivel slides, so as to deal with taper work, such as reamers, etc. In this machine the system of grinding with the face of the emery disk instead of the edge is adopted, and the advantages claimed for it are, first, that it leaves the backing off of the teeth straight, and not hollowed out, and consequently stronger and less liable to "snip off" when working; and secondly, the diameter of the face disk is not limited, as in the case of the edge disk, and consequently less wear takes place in grinding, and truer results are produced.



MILLING CUTTER AND TWIST DRILL GRINDING MACHINE.

The other engraving represents a machine recently constructed by the same makers for an important firm of engineers in the Midlands, and is specially designed for cutting out simultaneously the top and bottom ports in cylinder liners, etc., and for general circular slot drilling work. The two drilling headstocks are adjustable independently on the upright frame by rotating nuts and a fixed screw. The work to be operated upon is chucked on the circular table, which is adjustable along a slide bed to suit various diameters. A reciprocating rack, actuated by a connecting rod from elliptical wheels for imparting uniform traverse, gives an oscillating motion to the table, which can be readily adjusted for the various lengths of arcs. The spindle slides receive their inward feed motions at both ends of the stroke through a vertical rack. The machine is designed to operate on liners, etc., up to 28 inches diameter and 34 inches long.

We are indebted to The London Engineer for the cuts and article.



PORT CUTTING AND SLOT DRILLING MACHINE.

THE GROWTH OF INVENTION IN CYCLES.

In the whole history of our patent system none of the mechanical arts has inspired in an equal period of time such extensive and widespread inventive activity as those that relate to the cycle. In 1866, when Lallement filed his application for his now celebrated patent for a velocipede, only 20 patents had been issued by the United States for rider-propelled vehicles. At that time all of these were classified by the Patent Office as "carriages and wagons," and were included in the class having that official title. By January 1, 1869, 43 patents for such vehicles had issued. With the year 1869 the "velocipede mania" came upon our country. In that year velocipede patents were increased by about 200, and in consequence were grouped together as a subclass of "carriages and wagons," and officially designated "Velocipedes." After the mania of 1869, invention in velocipedes remained practically dead until 1876, when the English exhibit of bicycles at the Centennial Exposition gave it an impetus. Until the year 1890, however, when the influence of the pneumatic tire began to be felt, the growth of invention relating to cycles was comparatively slow. In 1890 one assistant examiner in the Patent Office was able to examine all applications filed in this class of invention. Since 1890 nearly 4,000 of the 5,000 United States patents for velocipedes have been granted. In 1892 the applications had become so numerous that velocipedes were collected into a class by themselves distinct from carriages and wagons and transferred to another division, which was then employed in the examination of velocipedes, harvesters and games and toys. The class was then split up into some 35 subclasses for convenience of examination. Applications accumulated so rapidly that games and toys were soon crowded out and sent elsewhere, and in May of 1897 harvesters also were forced out, and the class of velocipedes now forms by itself one examining division requiring the labor of one examiner, nine assistant examiners and five clerks to handle the great number of applications. And even with this expert force, a force larger than that of any other examining division in the Patent Office, passing on 800 applications, new and amended, each month, more applications are awaiting action there than in any other division. In fact, on an average during the past two years twice as many cases have been awaiting action in this division as in any other, and three times as many as in most of them. And with all, the class of velocipedes does not include motor cycles, wheels, tires, cycle accessories, nor the numerous special machines, all of which exist only because of the cycle. During 1892 about 600 velocipede applications were filed, in 1894 about 825, in 1895 1,500, in 1896 about 3,300 and in 1897 about 3,500, not including the various accessories, gear cutting and tube drawing machines and special machines designed for use in the cycle factory.

The number of patents granted in 1892 for cycles was in round numbers, 325; in 1893, 380; in 1894, 380; in 1895, 370; in 1896, 586; in 1897, including bicycle wheels and tires, 930.

Few patents are issued in the same year in which the applications for them are filed. Of the cycle applications filed in 1897 only about 100 went to patent in the same year. Increase in applications one year is more apt to result in an increase of patents in the year following than in the same year, as illustrated by a comparison of the applications filed in any one year with the patents granted the year following, in any particular line of invention.

The total number of applications for patents filed in the United States Patent Office in 1897 was something over 46,000. The whole number of patents granted, exclusive of designs, was 22,098, somewhat less than 50 per cent. of the applications filed. Estimates based on the applications filed and patents granted for a period of several years indicates that about 50 per cent. of all applications finally become patents. The proportion of patents to applications for improvements in cycles is much less than this. An estimate generalized from the records of the past few years shows that only about 35 per cent. of the cycle applications eventuate in patents. This is a natural result from the feverish activity of invention and the extreme difficulty of hitting upon a novelty in so well worked a field. That this small percentage of cycle patents allowed, as compared with the number of applications filed, is not due to excessive strictness of ruling on the part of the examiner is evidenced by the fact that 60 per cent. of harvester applications, formerly under the charge of the same examiner, used to result in patents.

As in other well worked arts, patents in the class of velocipedes are now granted almost solely for improvements in some specific details of cycle construction. Strange to say, the greatest number of patents in the cycle art relate to an accessory for which the demand is limited—that is, for cycle stands and racks, and devices designed to be carried on the cycle and turned into position to enable it to stand alone. For these 124 patents were issued in 1897. Patents for pneumatic tires come next in numerical strength with 110, including patents for punctureproof armor. Improvements in handle bars and grips and steering stems are claimed in 106 patents. Improvements in driving gear in 105, upward of 70 of these being for various chainless gears. There are 85 patents for bicycle saddles, 69 for brakes, 51 for frame constructions, 50 for pedals and cranks, 36 for guards, including gear cases, 17 for spring frames, 12 for tandems, 8 for bearings peculiarly adapted for

bicycle bearings (ball bearings, generally, being classed elsewhere), the remainder having reference to other parts of the cycle and to unicycles, polycycles of various types, carrier cycles and other practical or impractical "wheels" evolved from the inventor's brain.

One is bound to think that such activity must soon weary itself. Such impressions were rife a year ago, but the cycle inventor will not down, and his applications pour into the office at the rate of more than 225 a month. Considering that these relate only to the cycle proper and do not include the many other inventions that are directly inspired by the cycle, some conception of the amount of time and thought expended upon this most revolutionizing and useful plaything may be obtained.—The Iron Age.

HULT'S ROTARY ENGINE.

AN engine constructed by the Hult Brothers' Rotary Steam Engine Company, of Stockholm, was awarded a gold medal at the recent Stockholm Exhibition. It has since been working in Stockholm every day, and gives, we are told, entire satisfaction. We have before us the account of a trial, of a duration of 2 hours 40 minutes, in which the consumption of steam worked out to 48 lb. per brake horse power per hour. This is a wonderfully good result for a rotary engine, and our readers will no doubt be interested in learning the mechanical arrangements by which it was obtained.

The engine we illustrate in Figs. 1 to 5 is a double one; that is, it has two cylinders which receive steam alternately, like the cylinders of a locomotive, and hence it has no dead point, and the turning effort is fairly constant all round the circle. The most noticeable feature in Hult's rotary engine is the great reduction of friction due to the fact that the cylinder can rotate as well as the piston within it. Heretofore in rotary engines it has been customary to pack the edges of the piston or shutter and let them rub along the surfaces of the cylinder. In the engine before us the piston is a roller and the cylinder is likewise free to roll, the two moving at the same circumferential speed, but not at the same angular velocity, since the cylinder is of greater diameter than the piston. Of course, as in all rotary engines, the piston must make contact with the cylinder at two points, and the second must have a sliding contact. But as the cylinder and the piston are both moving in the same direction at nearly the same velocity, the work lost in friction is not great.

This arrangement of piston and cylinder necessitates somewhat large bearings. The friction of these, however, is kept down by the use of roller bearings, the rollers being slightly elastic to take up the wear. There are two such bearings at each end of the engine, one for the cylinder and one for the piston.

Referring to the illustrations, Figs. 1 and 5 are sections at right angles to each other of a twin engine. The steam enters at the right hand of Fig. 1, as shown, and finds its way into the central tube, in which there are ports (Fig. 5). It then passes through the passage, 2, and exerts a pressure on the shutter protruding from the rolling piston. It will be seen that the upper straight passage has just opened to the steam, while the lower passage, 2, which relates to the second engine, has been closed for some time, and that the steam is now expanding in that engine. The two curved passages each communicate with the exhaust, which escapes around the rotating cylinder. It will be understood that each rotating piston runs in contact with the cylinder and that the latter also rotates. Of course they run on different centers and the point of contact always remains at the top, as shown. This forms one closed joint and the shutter the other, the expansion of the steam taking place between them. The rotating pistons each run at one end against the end of the cylinder and at the other extremity against a loose plate. There are two of these plates in the middle of the cylinder (Fig. 1), and they can be forced apart to take up wear by pressing wedge-shaped pieces between them by means of screws, as shown. Each piston is, therefore, made steamtight by rubbing contact over the whole of its ends, while at one part of its periphery it makes a rolling contact with the cylinder, and at another part—the shutter—a rubbing contact which has relatively a very slow motion, since it and the cylinder are moving in the same direction at slightly different speeds. It will be noticed that Fig. 5 shows a broken section, the right hand half showing one engine and the left hand half the other.

The points of cut-off can be varied by rotating the inner tube by the aid of the handle shown to the right of Fig. 1. This has the effect of causing the port to be closed earlier or later by the rotating central piece, 1. It is by this latter piece the stoppage and reversal of the engine is effected, this operation being performed by the reversing lever shown. When this lever is in the mid position, the tubular piece, 1, will shut off the steam channel, 2, so that no steam enters the cylinder and the engine is stopped. If the lever be moved to the other end of the segment, the piece, 1, will be further turned so that the channel, 2, becomes the outlet for the steam, and the channel, 3, which previously was the outlet, becomes the inlet. In this manner the engine is reversed. The connection between the reversing lever and the tube, 1, is not very clearly shown in the engraving, but it will be seen that there is a link at the bottom of the machine, with a lever passing through the frame at the left hand end and operating a rod passing through the central shaft.

There are five sets of roller bearings in the engine, two for the rotating pistons, two for the cylinder and one at the end where the power is taken off. The piston bearings (Fig. 4) have each a movable roller path, which can be centered by means of screws to bring the pistons into the proper position to bear upon the cylinder. These bearings are on the outsides of the frame (Fig. 1). The cylinder bearings (Fig. 3) have each eleven rollers and are inside the frame. The remaining set of rollers form both a bearing and a transmission gear for reducing the speed of revolution. The five rollers run on pins (Fig. 1) projecting from a disk or face plate (Fig. 2) at the end of the shaft to be driven, each roller having a set of rollers in its eye to reduce wear and friction. The rollers are sprung into place between the central shaft and an external fixed roller path. As the shaft revolves it rotates the rollers, which carry the face plate with them, since they are in good frictional contact at each side. The result is that the speed of the outer shaft is reduced, in relation to the engine shaft, in proportion to

$$\frac{\frac{d}{D}}{1+\frac{d}{D}}$$

Fig. 6 shows a smaller engine having only one cylinder and no reversing gear.

It will be seen that the engine is an exceedingly ingenious attempt to solve the difficulties which have hitherto prevented the introduction of the rotary engine. The steam consumption mentioned above is far better than was ever attained before by a rotary engine not acting as a turbine, and will compare favorably with that of many reciprocating engines of the same size, viz., 4·3 brake horse power. Of the many advantages offered by rotary engines, from their small size, steady turning and freedom from inertia strains, it is needless to speak. They have been known for years, but the difficulty has been to realize them without the introduction of evils which overshadowed them. We are indebted to London Engineering for the engravings and article.

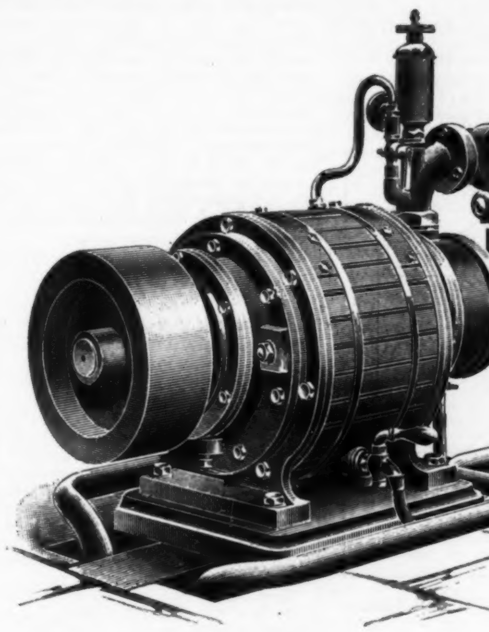
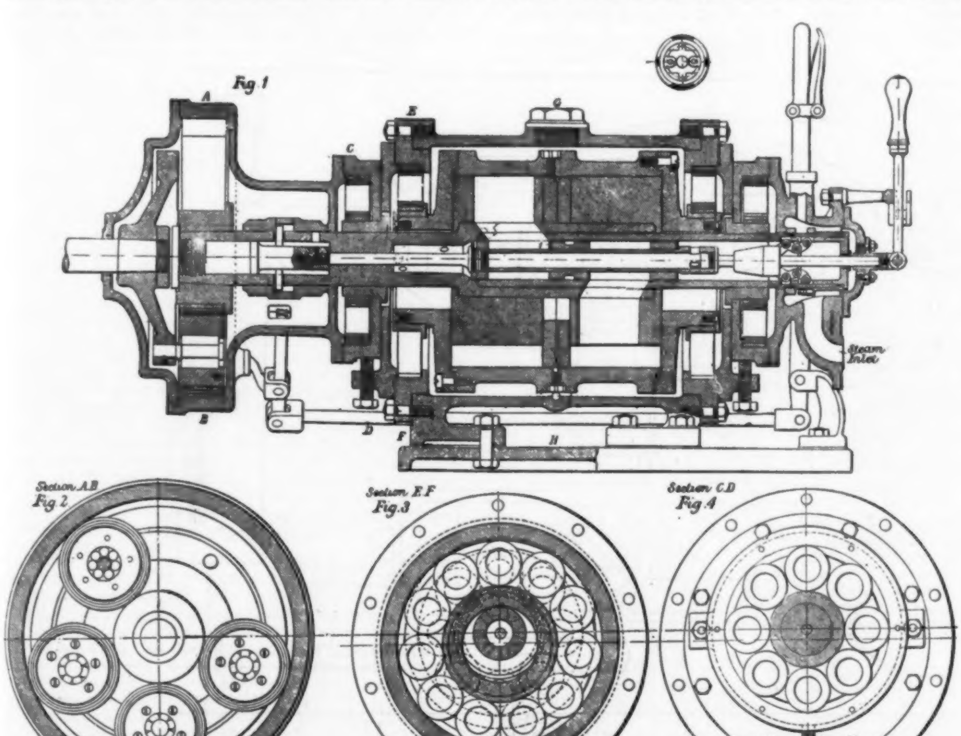
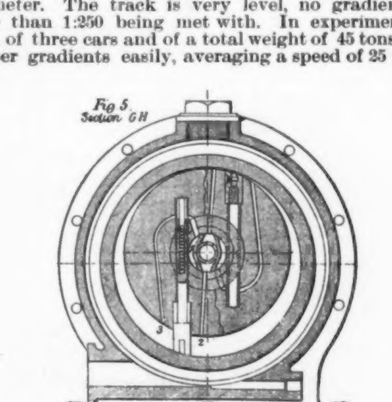


Fig. 6.





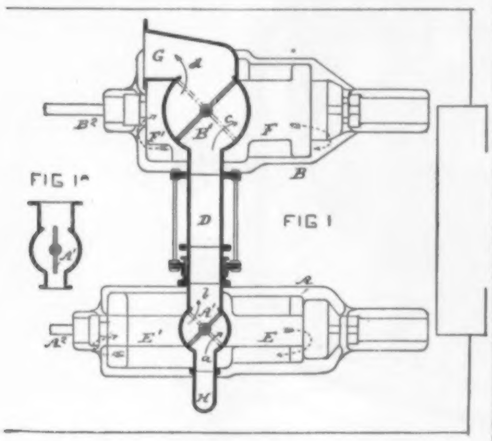
THE HULT ROTARY ENGINE.

The Chemin de Fer du Nord, of France, has made an interesting innovation in running Serpollet cars on its lines for very light local mail trains. They had to run trains for dispatching the mails, but they found very few passengers for them. An ordinary train, no matter how long, always requires a regular engine, which means considerable expense. Between Creil and Beauvais, a distance of 25 miles, a Serpollet car for 12 passengers and mails has been started. The trial run was accomplished in 100 minutes; the engine consumed 7 liters of water and 2 kilogrammes of briquettes per kilometer. The track is very level, no gradients of more than 1:250 being met with. In experiments a train of three cars and of a total weight of 45 tons took steeper gradients easily, averaging a speed of 25 miles per hour. On gradients of 1:76, a train of 36 tons moved with an average speed of 12 miles. The results are considered as quite satisfactory, but electric accumulator cars for 50 persons are also to have a trial. This would open a new field for the accumulator, for railway tracks are, as a rule, in a much better state than tramway lines, and would relieve the main line traffic. On some of our loop and local lines the idea might answer all the better, as English railways generally have a main and a local line track, which is rarely to be found on the Continent.

REVERSING STEAM TURBINES.

Aided by Mr. A. A. Campbell Swinton, whom we had the pleasure of meeting on board the "Turbinia" on the memorable occasion when she passed the 33 knots, the Hon. C. A. Parsons has succeeded in solving the problem of constructing a reversible steam turbine without adding to the number or complexity of the working parts, the improvement being obtained by simply altering the configuration of the blades and the proportional dimensions of the turbines of the series, and providing the necessary stop valves for controlling the reversal of the flow of steam. From this necessarily brief introduction it will be seen that the possibility of reversing is obtained without any appreciable complication of the mechanical construction of the turbine.

Considering first the arrangements made for controlling the flow of the steam, in a triple screw arrangement, it will be seen from the illustration shown below (which shows three turbines arranged, with regard to the steam flow, in series) that the reversing valves, A^1, B^1, and C^1, control the direction of flow through, respectively, the high pressure turbine, A, the intermediate, B, and the low pressure, C. The high pressure steam enters by the pipe, H, to either end of the turbine, A, as determined by the valve, A^1. From A the steam passes by the pipe, D, to the turbine, B, similarly controlled by the valve, B^1, and by the pipe, G, to the low pressure turbine, C, as directed by the valve, C^1, finally flowing to the condenser, K, by the pipe, I. A^2, B^2, C^2, are the propeller shafts; E, E^1 and F, F^1 are the steam passages controlled by the reversing valves; similar passages are provided for the low pressure turbine, C, but they are not marked.

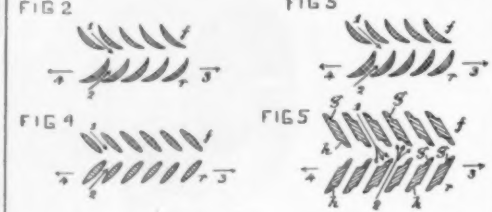


TWIN SCREW REVERSING TURBINES.

The reversing valves, A^1, B^1, C^1, are operated together by links, A^3, B^3, connected to suitable levers. In the figure the valves are set for going ahead, and the direction of the flow of steam for this condition is shown by the arrows.

As applied to a twin screw, the arrangement shown in Fig. 1 is adopted, A being the high and B the low pressure turbine. Steam passes from the boiler by the pipe, H, to the turbine, A, and for going "ahead" the steam passes on one side of the butterfly reversing valve, A^1, to the end of the turbine by way of the passage, E, as indicated by the arrow, a. The steam then passes through the moving and fixed blades to the opposite end of the turbine, whence it discharges to the passage, E^1, and so to the other side of the valve, A^1, as shown by the arrow, b, to the pipe, D, communicating with the turbine, B. The steam passes through that turbine for going ahead by one side of the reversing valve, B^1, to one end of the turbine, B, as shown by the arrow, c, thence through the blades to the other end, from which end it discharges by the passage, F^1, past the opposite side of the reversing valve, B^1, to the exhaust pipe, G, as indicated by the arrow, d. The reversing valves, A^1, B^1, thus direct the steam in combination with the passages, E, E^1 and F, F^1, so that the steam admitted to each turbine passes on one side of the reversing valve while the steam discharged from it passes on the other.

When desired to reverse both turbines the reversing valves, A^1, B^1, are placed in the positions indicated in dotted lines, and then the steam passes to the low pressure end of each of the turbines shown and discharges at each high pressure end. When one of the turbines is required to go ahead while the other reverses, one reversing valve is operated accordingly. To cut one turbine out of action the reversing valve is moved to its middle position, as shown in Fig. 1a. When in this position the steam passes on both sides of the valve, A^1 or B^1, without entering the ports, E, E^1 or F, F^1, as determined by the turbine to be cut out of action. When the turbine, A, is cut out, the steam passes by way of both sides of the valve, A^1, to the pipe, D, and thence to B. The valve, A^1, is so proportioned that when placed in the middle position the steam is throttled on its way to the pipe, D, to an extent nearly equal to the resistance of the turbine, A, when in action, and so with the proportioning of the valve, B^1. A^2 and B^2 are the propeller shafts.

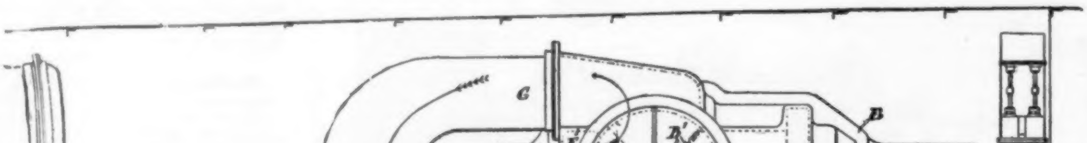


FORMS OF BLADES FOR REVERSING TURBINES.

Regarding the blades, Fig. 2 shows, diametrically, part of a row of fixed blades, f, and rotating blades, r; these are moderately curved, and converge in the direction in which the steam flows when the turbine is going ahead. When so rotating in the normal direction, the steam passes between the fixed blades, f, in the direction of the arrow, 1, impinges upon the concave sides of the rotating blades, r, and discharges from them, continuing in the direction of flow. The moving blades then rotate in the direction, of the arrow, 3.

When the turbine is to be reversed, the steam is caused to flow in the direction of the arrow, 2, and then it impinges on the convex sides of the blades, and travels in the direction in which the blades diverge. The turbine then rotates in the direction of the arrow, 4. The power developed during reverse running with blades as in Fig. 2 is sufficient for some purposes, but is much less than the power obtained when running ahead.

Fig. 3 shows blades less curved, having less converging and therefore less diverging effect, so that a greater power is developed while reversing. In Figs. 2, 3, 4, and 5 the fixed row of blades is indicated by f and the rotating by r; the arrows are also numbered similarly when the direction of flow of steam and rotation of turbine are similar.



TRIPLE SCREW REVERSING TURBINES.

In Fig. 4 the blades are straight and parallel to each other, so that equal power is developed while rotating in either direction.

Some loss of effect is occasioned by the straight or nearly straight blades, and the form of blade shown at Fig. 5 is intended to obtain greater economy while at the same time giving equal power in both directions. Here the blades are straight, but opposite convexities, g, h, are formed on each blade, so that in either direction of flow the steam jets impinge on a concavity. This is shown by the arrow, 1, splitting up as it impinges on the concave surface, g, of one of the row of moving blades, r. The turbine rotates in the direction of the arrow, 3, when the steam flows as indicated by the arrow, 1, and in the direction of the arrow, 4, when the steam flows as shown by the arrow, 2. In both cases it will be observed that the steam impinges on a concave surface.

The inventors are to be congratulated upon the accomplishment of a difficult task by such simple means.—Shipping World.

PROGRESS OF WORK ON THE PANAMA CANAL.

Under date of November 3, 1897, Consul-General Gudger, of Panama, issued a report on the progress of the Panama canal construction, which may seem somewhat surprising in view of the general impression that very little has been done since the old company went into liquidation several years ago. A new company was organized and work begun in 1894, since which time about 3,000 laborers on the average have been employed. The new organization is composed mostly of Frenchmen, as was the old one. Some time during the next twelve months a committee will investigate the progress of the work, and if a favorable report is made, it is expected that means can be procured for pushing the work more rapidly. The visit by this committee is looked forward to as a turning point, as then it will be decided whether the work will cease or be prosecuted with greater vigor. If after that time the work is continued at all, it is expected that the force will be so increased that the canal can be finished in from seven to ten years.

The canal is now practically finished from Colon, on the Atlantic, to Bujeo, a distance of 14 miles. The total length of the route from Colon to Panama, on the Pacific, is 54 miles. The work already completed is on the least difficult and least expensive part of the route. The width of the canal will be 160 feet on top and 72 feet on the bottom, except through the Culebra cut, where it will be 78 feet on top and 29 feet on the bottom. This cut presents the most difficult problem of the whole undertaking, and it was in consideration of the difficulties encountered at this point that the plan of building the canal without locks had to be abandoned.

Work was first begun on the canal in 1882, and continued until 1889, when there was an interruption until 1894. Most of the time from 1882 to 1889, 10,000 laborers were employed. It is estimated that fully $100,000,000 has been expended for machinery up to the present time, a large part of which is now scattered along the river and stored under sheds rusting away in the damp climate. The cost for labor, materials, salaries, etc., has been estimated at $275,000,000. The canal is about one-third completed and it is thought that, with what machinery and materials still remain, $150,000,000 will be required to complete the entire work.

A spiral railway tower is being planned as one of the features of the coming Pan-American Exposition at Niagara Falls, says Engineering News. The tower would be located on Cayuga Island and the general design is as follows: A steel skeleton circular tower would be built about 500 feet high and 80 feet diameter at the base, and 50 feet diameter 400 feet above the base. Around this tower, supported by strong brackets, would be a spiral railway, passing ten times around the tower in reaching the 400 foot platform. The motive power is to be electricity, with various safety appliances used in connection with the track. The spiral itself will be double, providing for independent up and down tracks, 20 feet apart. The designers of the tower are: Secretary R. C. Hill, of the exposition company; George A. Ricker, acting chief engineer of the company; and C. W. Ricker, electrical engineer of the Buffalo Traction Company. No exact estimate of cost is given, other than that it will cost from three-fifths to two-thirds of the amount expended on the Chicago Ferris wheel.

The number of applications for patents in Great Britain during 1897 shows an increase of 742 over the previous year and of 5,871 over those received during 1895, says Science. The number of patents applied for is not in itself a reliable index of the number of patents that may be issued. In the year 1896, of 30,194, 13,360 were completed, the rest being allowed to lapse after the nine months' protection. The inventions comprise every class of manufacture, but principally engineering.

ENGINEERING NOTES.

A gas tube made by the Mannesman Tube Company, of New York, was tested at the Watertown Arsenal, and burst at a pressure (hydrostatic) of 5,863 pounds per square inch. The details of the test, as published in the reports of tests of metals for 1896, which has just been issued, show that the tube was 87 inches long by about 5¼ inches in diameter, weighing 82 pounds. The fracture was in the form of a slit 13½ inches long, near one end of the tube. The elastic limit was reached at 4,710 pounds per square inch. The pressure was applied by means of a reservoir cylinder placed in the Emery testing machine, the piston of this reservoir being 3·37 inches in diameter, and the maximum pressure upon it was 52,300 pounds. The test was made for the United States Signal Service.

There are at present in the United States 40 tin plate plants, with 210 completed hot mills. At 12 of these plants there are being added 46 hot mills and there are 6 plants being built to contain 52 hot mills. This makes a total of 46 tin plate plants, to contain an aggregate of 302 hot mills. Of the 210 hot mills now completed and ready to run, there are at least 6 idle and not likely to be put in operation soon, and about 10 more are idle or only running part time. There are, therefore, about 194 tin mills actually running full time. Last January there were only 176 mills ready to run, of which probably 15 were idle, making 161 in operation last January, against 194 to-day, an increase of 33 since the beginning of last year, and with 92 more mills being built. And yet even at that time very little tin plate was being imported for domestic consumption.

A notable phenomenon, says The London Engineer, recently occurred at the Royal Arsenal. It seems that in experimenting on firing gas in mines a special gun is employed to do duty for a bore hole with a charge of high explosive, and pressed cylinders of raw, dry clay, three inches long and nearly that in diameter, are used to represent tamping. These shots are made to act in various mixtures of air, coal dust and gas, and to stop the course of the plug eventually, a cast iron target plate, an inch thick, was placed twenty-five feet in front, at an angle of 45°, in order to break up everything into dust and throw it upward. After three or four shots with this arrangement the clay plug, weighing 7½ ounces, perforated the inch iron plate, and the hole thus made has been steadily extended since. This is to be appreciated in view of the fact that the calculated velocity for a hard cylinder of this weight and size, to cut through an inch of wrought iron at an angle of 45°, would be over 1,800 foot seconds.

The Glasgow correspondent of a London iron trade organ writes as follows, says Bradstreet's: "Not many years ago nearly all the American and continental mercantile marine was constructed on the Clyde, but during the past twelve months not a single German boat was placed on the Clyde and only a very few for America. A year ago the complaint was that orders had gone so often to the north of England, but the cry of 1897 is that they have gone to the continental yards. Indeed, 1897 has shown distinct evidence that the proud boast of the Clyde as to the premier shipbuilding claim has been lost. The Germans during the year have made strides which were never made in the palmiest days of Clyde building. The Fatherland has not only eclipsed our engineering feats, but got a firm grip of the world's shipbuilding. Trades unionism is having its innings. During the past six months there has been a vast amount of capital lost through idle machinery, and as shipbuilders nowadays accept a good part in shares as payment for ships, the loss to the builder has cut both ways."

Very little attention has yet been given to the matter of utilizing the waste heat of the exhaust gases from gas engines, in spite of the fact that improvements in this direction promise a not inconsiderable economy, says The Iron and Coal Trades Review. In an average gas engine the escaping gases are heated to about 950° Fahr., and if the maximum temperature be assumed as say 2,700°, the theoretical efficiency would be about 53 per cent.; but if the temperature of the exhaust gases could be usefully lowered to 300° with the same initial temperature, this theoretical efficiency would rise to 76 per cent., with a corresponding increase in actual efficiency. This is sufficient to show what advantages may be gained in this direction; but it is noticeable that the most successful gas engine builders appear to regard the method of external refrigeration as a necessary evil, and make no very serious attempt to do away with it. The case as it stands at present is that, putting aside the losses due to radiation and conduction, which total to about 65 per cent., we have about 17 per cent. of the total heat of combustion converted into available power, while an almost equal quantity of heat passes away with the exhaust gases without having performed any duty.

The following railway lines have been built in China or will be constructed within a few years, the necessary concessions having been granted: 1. Shanghai-Wusung, completed in 1873, but closed to traffic owing to the fanatic opposition of the population. 2. Tientsin-Shenhaikwang (at the eastern end of the Chinese wall), 173 miles, opened for traffic in 1890. This line is to be extended to Mukden, Kirin and Vladivostok, to connect with the Transsiberian Railway. 3. A railway line will connect Stretensk, in the Transbaikal government, with Vladivostok, passing through Manchuria. 4. The line Pekin-Tientsin, 80 miles, has been opened to traffic in May, 1897. 5. A Belgian syndicate is building a line from Pekin to Hankow. This city, with a population of nearly 3,000,000, is probably the third largest in the world, and has a very important river harbor. 6. A line will be built in a southwestern direction from Pekin to Tai-yuen, the capital of the province of Show-Sin, a distance of about 280 miles. 7. A part of the Chinese loan was to be used for the construction of the line Shanghai-Nankin. 8. The British are building a railway from Mandalay, Burma, to Talifu, province of Yunnan. This line has been completed as far as Kunlonferry. 9. The French are pushing northward from Hanoi to Laokai and Mongtse, province of Yunnan, southern China. 10. The Chinese themselves will construct a railway from Takoi, Canton, northward, the terminus of which will be probably at Nankin or Hankow.—**Uhland's Wochenschrift.**

MISCELLANEOUS NOTES.

A large package of celluloid combs which was placed under the seat and near the steam pipe in an elevated car in New York recently ignited from the heat.

Klingenberg-am-Main, in Franconia, as a result of the municipality engaging in business has no taxes to pay and distributes profits to the individual citizens. The town runs terra-cotta works, the profits on which last year, after the town expenses had been paid, were 90,000 marks.

A greater quantity of paper was exported from the port of New York during the week which ended January 12 than was ever shipped in any one week before. The value of the exports was $70,891. Nearly $30,000 worth of paper was sent to London. Over $15,000 worth went to Manchester, and there were large consignments to Brazilian ports, to Brisbane, to Glasgow, to Lyttleton and to Mexican ports.

During the past year 888 cavalry and 81 artillery horses were purchased for the army at an average cost of $133.10 each for cavalry horses and $146 each for artillery horses. During the same period 42 team horses and 344 mules were purchased, says The Army and Navy Journal. The average cost of the former was $158.54 and of the mules $90.19. There died or were sold during the year 1,061 cavalry and artillery horses, 30 team horses and 305 mules, leaving on hand 6,006 cavalry and artillery horses, 535 team horses and 3,148 mules.

Very satisfactory official reports are given of the 15,000 aluminum utensils used by the French army in Madagascar. They proved far superior to white metal. M. Marcel Guichard, in the Revue de Chimie Industrielle, accounts for the check to the general use of the metal, in spite of its having decreased in price to four or five francs a kilogramme, to the fact that it is still difficult to obtain aluminum in a perfectly pure state, and that the presence of even very small proportions of foreign matter, such as carbon or sodium, alters its qualities.

Efforts are being made to have Wolmer Forest, in England, turned into a sanctuary for wild birds. Since 1895 the Officers' Shooting Association, of Aldershot, has taken over the game preservation of the forest grounds, and all wild birds have been studiously protected. A typical result of this has been that, instead of one heron's nest a few years ago, there are now twenty, and nearly fifty young herons flew from the nests last year. The efforts of the association are, however, nullified to a large extent by the destruction of protected birds whenever they emerge on to the private lands surrounding the forest.

St. Louis, the greatest brick manufacturing center in the United States, is headquarters for the Hydraulic Pressed Brick Company, which has in St. Louis the two largest yards in the world, and eleven factories in other places, the whole having a yearly output of 300,000,000 bricks. Its St. Louis warehouses are miles in length, says The New York Times. The company owns 58 railroad clay cars, with a capacity of 60,000 pounds each. Power is supplied by 14 boilers and 16 engines, 276 mules and 600 men. The machinery is all patented and made by the company, which owns its own blacksmith's and machine shops, foundry, harness shops and wagon works, and turns out in its own plant everything it uses.

The Madras Railway Company desires to encourage persons to settle and build houses on the route of their line near to stations within easy reach of Madras, says Industries and Iron. They therefore offer to issue a free third-class periodical pass, renewable for a total period of five years, in favor of one person (owner or tenant as the case may be) occupying any new house at or near any of the stations from Connur to Trivellore inclusive, provided the following conditions are complied with: (a) The house must have been built since March 1, 1896. (b) It must be situated within a radius of one mile of the stations named. (c) The site of the house must be approved by the company's chief engineer, and the value of the house must, in his opinion, be not less than Rs. 1,000.

Railroad life in Germany leaves a good deal to be desired, says Locomotive Engineering. It is stated that out of a total number of persons employed on the state railways (274,264), one-third are on duty twelve hours daily. Nearly 20,000 work thirteen hours; 12,000 are employed fourteen hours, and nearly 5,000 work fifteen hours, and a similar number sixteen hours. Among 18,844 engine drivers and stokers, nearly 3,000 work thirteen hours a day, 2,743 fourteen hours, 1,273 fifteen hours, and 1,096 sixteen hours. The pointsmen number 18,867, and of these 11,234 work from ten to twelve hours, 1,771 thirteen hours, 1,105 fourteen, 278 fifteen, and 202 sixteen hours. Under these circumstances it is no wonder there are frequent accidents, and that the reproach is brought against the railway department that a false economy underlies all these arrangements with the employés. As the income of the department exceeded expenditure last year by the enormous sum of 469,500,000 marks (£23,475,000), more liberal treatment of railway men is demanded.

Rapid test soundings were required in some work on a railway line between Paris and Havre, where the cast iron viaduct of Bezons was replaced by an arch bridge alongside. The old foundations for six channel piers were removed to the bottom of the river. It was required that the river bed should be carefully leveled. After it had been dredged, the bottom was explored by means of a horizontal bar of iron about twenty feet long, which was suspended at each end from a framework uniting two flat boats in catamaran fashion. This beam was lowered close to the bottom and the boats were gradually moved along in the direction transverse to the length of the bar. When the scraper encountered no irregularity, the suspending chains hung vertically, but as soon as either end was deflected by contact with any obstruction, an electric circuit was closed, which caused an alarm to be rung. The boat was stopped and the obstruction located by means of sounding poles. In this way small stones, down to a diameter of four inches, were easily located, and the bed of the river was leveled to within that amount of irregularity. This method proved rapid and successful.

SELECTED FORMULÆ.

Decolorized Aluminum.—The American Druggist states that gray or unsightly aluminum may be restored to its white color by washing with a mixture of 30 grammes of borax dissolved in 1,000 grammes of water, with a few drops of ammonia added.

To Make a Casting of Precisely the Same Size of a Broken Casting Without the Original Pattern.—Put the pieces of broken casting together and mould them, and cast from this mould; then anneal it. It will expand to the original size of the pattern, and then remain in that expanded state.

How to Anneal Brass or Copper.—In working brass or copper it will become hard, and if hammered to any great extent will split. To prevent cracking or splitting, the piece must be heated to dull red heat and plunged in cold water; this will soften it, so it can be worked easily. Be careful not to heat brass too hot, or it will fall to pieces. These pieces must be annealed frequently during the process of hammering.

Soap for Metals.—

	Parts by Weight.
Cocoanut soap	100
Chalk	8
Alum	3
Cream of tartar	3
White lead	3

Cut the soap into slices and melt it in an iron vessel, adding a little water. When the soap is thoroughly melted, add the other ingredients, mix the whole thoroughly for ten to fifteen minutes, then run it into moulds of white metal.

Formalin Mouth Water and Tooth Paste.—Canz gives the following formulas: Mouth water: Mix 50 parts of 40 per cent. formaldehyde with 1,000 parts of alcohol, then add 200 parts of tincture of benzoin, 50 parts of tincture of myrrh, 3 parts of oil of peppermint, 2 parts of oil of anise, 1 part of oil of cassia, 15 parts of oil of cinnamon (Ceylon), and 2 parts of powdered cochenille. Mix well and filter. Tooth paste: Triturate together 1,000 parts of best prepared chalk and 30 parts of 40 per cent. formaldehyde. Then mix with 200 parts of powdered orris root, 50 parts of magnesium carbonate, 100 parts of powdered soap, 10 parts oil of peppermint, 2 parts oil of bergamot, 1 part of oil of lemon and 700 parts of chemically pure glycerin. Instead of 10 parts of oil of peppermint, 5 parts may be taken, with 3 parts of menthol.—Seif.-Oel- u. Fettind., through Drog. Ztg.—Pharmaceutical Era.

Alloys and their Melting Points.—The following alloys will melt in boiling water or at a lower temperature:

	Tin.	Lead.	Bismuth.	Cadmium.	C.	F.
Newton's	3	2	5	0	100 deg.	212 deg.
Rose's	3	8	8	0	95 "	203 "
Erman's	1	1	2	0	93 "	199 "
Wood's	2	4	7	1	70 "	158 "
Mellott's	5	3	8	0	93 "	200 "
Harper's	4	4	7	1	80 "	180 "

Erman's alloy can be made of equal parts of plumber's half and half solder (equal parts tin and lead) and bismuth. Harper's alloy can be made of 8 parts of plumber's half and half solder, 7 parts bismuth and 1 of cadmium, and can be poured into a modeling composition impression. It is hard enough to withstand the hammering required, and makes a smooth, sharp die.

How to Raise Mushrooms.—No family that cares to take the trouble need be without fresh mushrooms the year around, if they have room in the kitchen or anywhere else around the house for an old bureau or chest of drawers which can be used as a cultivating bed. The writer (Nat. Dr.) for several years kept such a cultivator in an unused room of his house, and was rarely without his fresh champignons for breakfast. The arrangement is as follows: Fill the drawers, to the depth of six or eight inches, with an intimate mixture of good, rich soil and old, dry horse or cow dung, in equal parts. Having done this, procure from your dealer in seeds, etc., some fresh mushroom spawn (the French is the best), and insert it at various points on the surface of the soil. Sprinkle (not too heavily) the surface, and the beds are ready. If the drawers close tightly in front, the back of the stand should be removed, and a curtain tacked up in such a manner as to shut out the light. The mushrooms will begin to show themselves plentifully in a few days, but it will be a fortnight before any fit to eat can be gathered. The bed will last, with an occasional watering, for many months, and furnish almost daily a good mess of champignons.

Condition Powder for Stock.—

1. Cream of tartar	5	pounds.
Sulphur	5	"
White resin	5	"
Gum guaiacum	3	"
Potassium nitrate	2	"
Gentian	5	"
Sulphuret of antimony	6	ounces.

Reduce the ingredients to fine powder and mix intimately.

2. Sulphur	2	pounds.
Fenugreek	4	"
Cream tartar	1	"
Licorice	1	"
Black antimony	½	"
Gentian	¼	"
Aniseed	¼	"
Common salt	1	"

Dose, 1 ounce daily for 2 or 3 weeks.

3. Powdered fenugreek	3	ounces.
Powdered black antimony	2	"
Sulphur	4	"
Powdered resin	2	"
Powdered nitrate of potassium	3	"
Epsom salt	6	"

4. Saltpeter	1	ounce.
Ginger	2	"
Fenugreek	3	"
Black antimony	1	"
Licorice	1	"
Linseed meal	8	"

—Pharmaceutical Era.

THE GOBELINS MANUFACTORY AT THE EXPOSITION OF 1900.

THE works of the Gobelins are necessarily of very slow execution. Everything is done by hand, and a Gobelins tapestry is to a fabric woven on a Jacquard loom what an art painting is to a chromo or to wall paper. The tapestry artist is not asked to produce much, but to give his work all the perfection possible, regard being had to the model that he is to interpret.

In view of the Exposition of 1900, a certain number of tapestries and carpets, the patterns for which were ordered from the best artists of our time, have been put upon the loom. Since it requires no less than three years to finish such work, there will be selected at the opening of the Exposition those pieces that appear most worthy of the old reputation of the establishment.

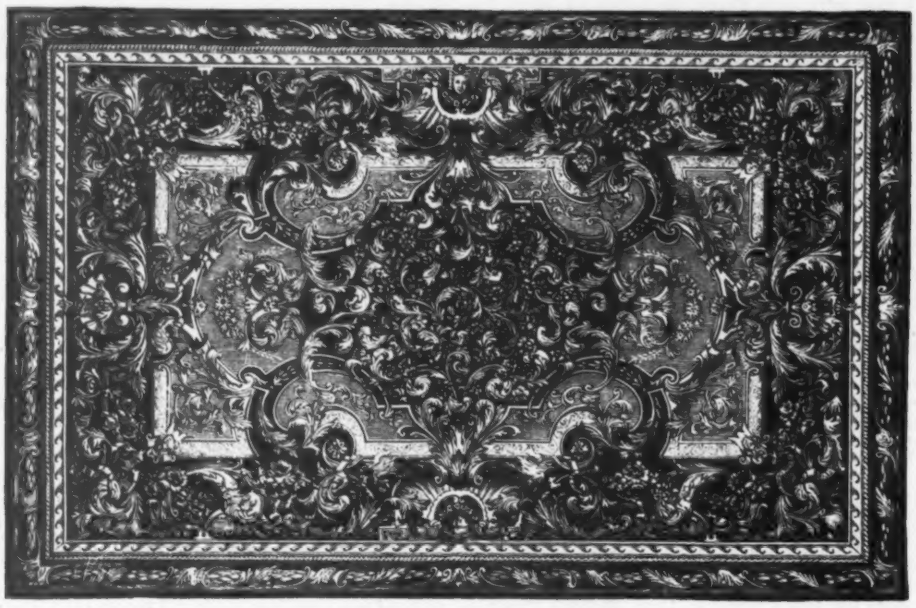


FIG. 1.—CARPET DESIGNED BY M. LIBERT.

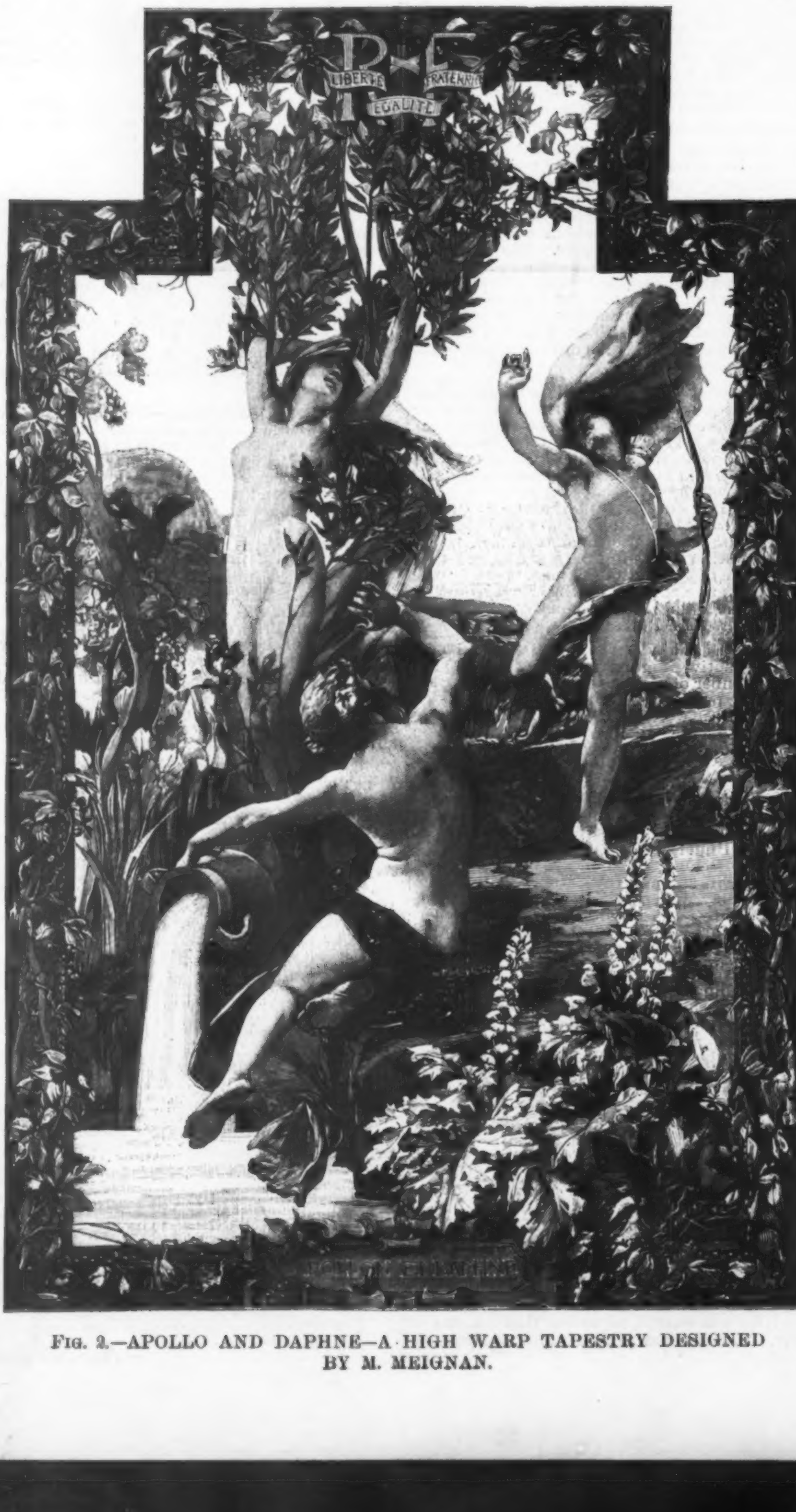


FIG. 2.—APOLLO AND DAPHNE—A HIGH WARP TAPESTRY DESIGNED BY M. MEIGNAN.

We shall mention a few of these works that are already far advanced, in recalling the fact that the manufactory is open to visitors (without tickets of admission) on Wednesdays and Saturdays, from one to three o'clock. The work represented in Fig. 2 is Apollo and Daphne, by M. Meignan. Like the artists of preceding centuries, M. Meignan has chosen to treat a mythological subject, and has well succeeded in a style of art that has been wrongly considered as out of fashion, since Greek mythology will always be the live source of the finest artistic inspirations, despite the abuse that has been made of it for works of high order.

Another mythological subject is the Siren and the Poet, by M. G. Moreau, which one had an opportunity of admiring at one of the last salons. This model is of an original and very striking effect. The artist has represented the ocean bottom with its real productions, which seem to be absolutely fantastic as to form and color. The siren appears to be well endowed with that languishing and irresistible charm so well described by Homer. Moreover, as in the preceding work, the coloring is bold and the tones are harmoniously chosen.

Some reproductions of the old models of Boucher (Aminta and Silvia, etc.) are also very remarkable. In the mystic line, M. J. P. Laurens has given the Mission of Joan of Arc.

In an entirely different line, let us mention the charming picture by M. Claude, so fresh in color and so ingeniously composed, the Civil Marriage in 1792, designed for the Salle des Mariages of the mayoralty house of Bordeaux.

In the Savonnerie loom shop, which has been connected with the Gobelins since 1828, work is in progress upon two large imitation velvet carpets after designs by M. Libert. Fig. 1 represents the motive of ornamentation of one of these carpets, but it can give no idea of the harmony and richness of colors of this beautiful work.

It is generally known that the Gobelins tapestry is a genuine fabric, a kind of reps, the warp of which is covered by a double passage of woof. There is therefore no "Gobelins stitch," although ladies often speak of such a "stitch."

There is no Beauvais tapestry of which the aspect is absolutely the same as that of the Gobelins. The loom itself is different. That of Beauvais is what is called "low warp" and that of the Gobelins "high warp," and all simply because in the first the warp is horizontal and the heddles are placed beneath, while in the second the warp is vertical and the heddles are above the artist's head. What is a heddle? A simple string carrying a loop through which each warp thread freely passes. In order to draw upon the warp threads, the low warp tapestry worker uses pedals that act upon the heddles, while the high warp worker uses his hands for maneuvering the heddles.

Most romancers believe that high warp tapestries are superior to all others, and would be afraid to give a middling description of the richness of a drawing room by saying that it was ornamented with low warp!

The carpets of the Savonnerie (so called from an old factory of Chaillot, in which this manufacture of "grande luxe" has long been installed) resemble Axminster with very long pile, and are manufactured by hand with particular care. It is a work still more costly than that of tapestry, but the results of which are of incomparable richness and beauty.—La Nature.

BLACK PRINT PROCESSES.

By ALBERT E. GUY.

ALTHOUGH the heliographic reproduction of drawings in black lines upon a white ground has been attempted by many, yet it has not been possible to find a process comparing favorably for simplicity and beauty with the ferro-prussiate or blue print process. It is necessary to review briefly this latter with its numerous qualities in order to bring into relief the difficulties attending the manufacture of black print paper. As the blue print paper has been on the market for many years and has given full satisfaction, the black print, to find favor with the public, had to be made at least as good and as cheap. This explains the obstinacy of the inventors bent on improving the process; for, if the blue process had not been known, the black, although imperfect, would have satisfied everybody; but the latter had a successful rival to upset, and it suffices to say that the race is still running.

Blue prints can be made on cheap paper; the chemicals used are not expensive and the method for applying the sensitizing solution is very simple; the prepared paper remains in good condition for about one year; very little skill is required for making the prints, and these can be kept indefinitely, and, furthermore, improve in beauty with age. With the blue process a print can always be made in ordinary weather conditions, and whether very light or very dark in color, the print can be serviceable.

It has, however, two defects: First, the print obtained from a positive drawing (generally made on tracing cloth or paper) is a negative, showing white lines on a blue ground. This is objectionable in certain cases. Second, it is difficult to make alterations of lines or figures on the plans.

Considering here only the simplest and most used black print processes, those in which the sensitizing solution is composed in part of iron salts, it has been found that a paper of the best quality, consequently very expensive, is necessary; the chemicals are more numerous and their solutions require more care to make and to apply than those of the blue process; the prepared paper keeps with difficulty more than three months; it rots from the time it is made, and is completely destroyed six or eight months after being sensitized. This partly explains why such good quality of paper is necessary, for strong paper will resist longer. It must be understood that only the prepared paper rots; but the print developed and washed ceases to rot and remains indefinitely in the same condition it was at the time of printing. It requires a certain skill to expose and to develop the prints, and these have the grave defect that they are bound to fade as

they age in the same manner as writings made with common ink.

The black print process can be divided into two classes: First, those requiring a developing bath after exposure, and, second, those requiring only a water bath, the same as the common blue process.

Poitevin discovered that in a solution of iron chloride, containing an organic acid, such as the oxalic, tartaric or citric, when exposed to sunlight, the iron salt is decomposed; in other words, the ferric chloride is reduced, and becomes ferrous chloride. He also found that if such a solution is spread on a sheet of white paper, in a dark room, and allowed to dry, then is placed under an ink tracing in a printing frame and exposed to the sunlight, after a few minutes, the sensitized paper being withdrawn, a faint copy of the lines of the tracing is visible in yellow upon a white ground. It remains now to fix the image and to bring it out in a darker tone in order to utilize it. Wherever the light has touched the surface of the paper, the chemicals have been transformed and the iron reduced to the ferrous state; but under the lines of the tracing the light has not penetrated, and consequently the chemicals have not been acted upon; the iron is there in the ferric state.

After experimenting with numerous substances, it was found that tannic and gallic acids were the best to use for developing and fixing the image or copy of a tracing. By dipping the exposed paper in a solution of one of these acids, the yellow lines become black and the background assumes a grayish tint. The lines are darker when gallic acid is employed. The role played by the gallic acid is explained at length in the treatises on chemistry; it suffices here to say that in the presence of a ferric salt in solution gallic acid precipitates the iron in the form of a bluish black mass; whereas in a ferrous salt solution the acid produces no precipitate, but causes a slight blue coloration, which tends to deepen if the solution is exposed to the air. Now, when the print is dipped in the gallic acid solution, the above reaction takes place; the yellow lines contain iron in the ferric state, and this iron is precipitated in black to the surface of the paper and becomes insoluble; the background is tinted slightly. The impossibility of obtaining a clear white background was due not only to the unavoidable reaction of the developer on the ferrous salt, but also to the fact that the solution sank into the paper and remained there in its original state, the light acting, for such a short exposure, only upon the surface of the sheet; consequently, the developing solution, also sinking within the paper, formed with the ferric salt therein a black precipitate of less intensity than that of the image, but which deepened the tint of the background to such a degree that in certain cases the prints were execrable.

It was thought then to thicken the sensitizing solution to prevent it from penetrating the paper. Gelatine and gum arabic were tried, and to-day form parts of solutions used with success. It was also found that a solution of iron chloride, tartaric acid and gum arabic in aqua, spread on paper and dried in the dark, forms a nearly insoluble compound, but when exposed under a tracing to sunlight, the insolated parts become soluble again, whereas the spaces covered by the lines of the tracing remain insoluble, but are nevertheless impregnated by the developing solution of gallic acid, and turn blue black, while the background washes away and becomes nearly white.

If the ferric chloride is the only iron salt used in the solution, the image of the developed print will fade quicker than when another salt, such as the ferric sulphate, is added. This latter, in conjunction with an organic acid, is capable of producing an image, but it is very difficult to fix it. The lines run and generally wash away, and the time of exposure is very long. But when this salt is used with the chloride it does not prevent the decomposition of the different chemicals and its iron is precipitated in blue black along with that of the chloride not reduced by light, and thereby gives more body to the lines of the print. In the insolated parts the ferric sulphate is reduced just as quickly as the chloride, because of the presence of the latter, and is washed away when developing, helping thus to clear the background, because the salt does not form an insoluble compound with tartaric acid and gum arabic.

This sulphate is generally sold in the form of solution labeled "Tersulphate of Iron," and it contains 28·7 per cent. of the salt; consequently, when a formula calls for a certain weight of sulphate, by using this prepared solution the amount of water in which the salt is dissolved should be deducted from the quantity of water prescribed in the formula. For 28·7 grammes of salt there is in the solution 100—28·7=71·3 grammes of fluid and for 1 gramme there is $\frac{71·3}{28·7} = 2·48$ grammes of water, say $2\frac{1}{2}$ grammes in round figures, and solution itself weighs $3\frac{1}{2}$ grammes. Multiplying $3\frac{1}{2}$ by the weight of salt required, the product gives the amount of tersulphate solution to employ; subtracting from this the weight of the salt, the result indicates the amount of water to be deducted from that given in the formula.

It is certain that of all the iron salts for this purpose the best to use is the tersulphate. Some persons advise the subsulphate of iron solution, containing 67·5 per cent. of the salt; but with it the results are not satisfying; the lines of the print have a tendency to run when the sheet is hung up to dry and the image is blurred.

Of the three organic acids the tartaric acid gives the best results. The oxalic acid solution prints rapidly, and when the paper is freshly made the exposure required is sometimes less than thirty seconds in a good sunlight at noon time; but the lines of the print run and the background is very dark. The next day at the same hour the time of exposure is between five and ten minutes. The third day the prepared paper is generally worthless.

The citric acid makes the paper print slowly, and while causing the lines to run when the sheet is drying, is still better to use than the oxalic acid. The tartaric acid solution prints in good sunlight, generally from 9 A. M. to 5 P. M. in summer time, in about four and a half minutes, during the three months from the date at which the paper was sensitized.

It remains now to speak of the paper. After trying all kinds of paper with a view to reduce the first cost, the experimenter will see that the Steinbach paper from Malmedy, Germany, is the only one giving full satisfaction. It is very expensive, since when bought in rolls of about 150 pounds and all duties paid, it costs about 30 cents a pound. It has to be very strong, and the quality generally used weighs from 120 to 125 grammes per square meter, which for a 10 yard roll of paper 36 inches wide amounts to about $2\frac{1}{4}$ pounds. Consequently the first cost of a 10 yard roll is 2·25×30 =$67\frac{1}{2}$ cents. This explains the high price at which the black print paper is sold.

The following formula is deemed the best the writer has tried, and will give excellent results:

Water	275	parts
Gum arabic	20	"
Tartaric acid	10	"
Ferric chloride (solid)	15	"
Tersulphate of iron solution	35	"

These quantities should all be weighed, so as to insure correct proportions. The water must be very pure and if possible distilled. The gum arabic may be in granulated or in powder form, dissolving thus in a very short time. To make the solution, dissolve the gum arabic in about eight times its weight of water; when the liquid is clear add the tartaric acid; this will dissolve quickly; then add the iron chloride, which should have been previously dissolved in a vessel containing the remaining quantity of water, and finally add the tersulphate solution. Instead of gum arabic, gelatine can be used; but the prints do not wash then as easily. Corresponding to the quantities above stated ten parts of gelatine would be required. Place the gelatine (in sheets) in a vessel containing 150 parts of cold water. After several hours it is thoroughly soaked; place the vessel in a hot water or a sand bath and leave it there until the mass is completely dissolved. It is well to stir the liquid often, so as to prevent deposits at the bottom, which would greatly retard the dissolution. When cooled, add to this solution the other ingredients in the order given above. The paper sensitized with any of these solutions has a pale yellow appearance, and while making prints it is difficult to time the exposure, the lines of the prints not being easily distinguishable from the background. It is good then to add to the solution a small quantity of sulphocyanide of potassium. This substance is white, but in presence of a ferric salt it colors the solution a deep red; whereas no coloration takes place in presence of a ferrous salt. Consequently, when printing, the lines will appear in red upon a white ground, thus indicating a sufficient exposure. The sulphocyanide does not influence the fixing of the copies; instead, the tartaric acid being freed by washing from the iron which is precipitated by the gallic acid, attacks the sulphocyanide and destroys the red coloration left in the places not insolated.

After printing, the copies should not be allowed to stand very long undeveloped. Air acting upon the ferrous salts would transform them, in part, into the ferric state and that would cause the prints to be dark gray and hardly readable. From the frame the sheets should be placed in a shallow tank, containing a solution of gallic acid in the proportion of one part of acid to 300 parts of water. Keep the prints moving until the lines are very dark and the image is visible in all its details; then dip them in another tank full of cold water; rinse well and hang up to dry.

A word about sensitizing. Do not attempt to sensitize the paper by hand with a sponge or a brush in the same manner as blue print paper is prepared in some shops. It makes very little difference in a blue print whether the solution is thicker in one place than at another; the background being blue, the tint may vary in places without interfering with the lines of the drawing. It is well to remember that when blue print paper is freshly prepared and dry the film is soluble and can be readily washed from the paper. In fact, as a test of the good quality of the solution, manufacturers often place a piece of their new paper in clear water for a few minutes. If the paper is entirely white after washing, the solution is good; if the paper is slightly tinted blue, the solution is acid and generally emits an odor of cyanhydric acid. In such a case the lines of the prints will not be clear white.

The black print solution, as soon as dried, is insoluble; consequently, if the sensitizing has been carelessly done, the thickness of the film may not be uniform. As the background must be white, if the exposure is not long enough the print will be dark and streaks will be visible all over the sheet, and will interfere with the lines of the drawing. If the exposure is too long, the iron will be entirely decomposed in certain portions of the drawing where the solution was thin and will wash away, thereby rendering the print useless. It is better to buy the paper all prepared and ready for use.

A number of formulæ will be found in books treating on photography, but the formula given above is very good and produces excellent results.

As many objections have been made against the acid developing bath paper, manufacturers have extensively experimented with chemicals of all kinds in order to find a sensitizing solution containing a developer. Their aim was to make the black print paper as easy to manipulate as the blue. The next and concluding article will give the most complete details about the water developing black print papers.—American Machinist.

FIG. 1.—REPRODUCTION OF A PHOTOGRAPH SHOWING A BOLT OF LIGHTNING STRIKING THE EIFFEL TOWER.

FIG. 2.—VIEW OF THE TOWER AND ASPECT OF THE SKY AT THE END OF THE STORM.

NOCTURNAL PHOTOGRAPHS OF THE EIFFEL TOWER.

WE reproduce herewith, from La Nature, two photographs of the Eiffel Tower taken in the evening of May 31, 1897, by M. G. Loppé from a window on Trocadero Avenue. They are of interest in the first place because they were taken long after sunset, and in the second because they clearly show all the details of a bolt of lightning that struck the great iron structure.

During this evening, M. Loppé constantly followed with the objective of his apparatus a storm that began at about nine o'clock, and was enabled to obtain several negatives of it. In the last two photographs (those which we reproduce) the storm was, with respect to the operator, in the direction of the Eiffel Tower, that is to say, nearly to the south.

In the first photograph (Fig. 1), taken between 10 h. 10 m. and 10 h. 25 m., we observe the image of several flashes that occurred successively, and one of which struck the summit of the tower.

At the moment of the fall of this bolt, the rain was descending in a torrent, and this explains the great width of its image.

The second photograph (Fig. 2) was taken immediately afterward, while the storm was moving in the direction of the south. The flashes, which descended outside of the field of the objective, illuminated a por-

tion of the heavens, and the clouds to the left are for this reason perfectly outlined.

Although the focusing was the same for the two negatives, the image of the tower is much sharper in the second, since the rain had ceased to fall. In both cases the time of exposure was about fifteen minutes.

M. Loppé has taken a large number of night photographs during the last ten years, and has succeeded in obtaining some very remarkable negatives. It is certain that, in order to succeed, it is necessary to have considerable experience in the determination of periods of exposure according to the intensity of the light and the sensitiveness of the plates employed.

At first, a person experiences some little trouble and naturally loses a certain number of plates, but after a few trials he will succeed in judging with sufficient accuracy how long the exposure should be in order to obtain interesting negatives.

Another difficulty is the focusing, which is a somewhat delicate matter and requires much attention. Of course, we can do the focusing in the day time and afterward patiently await the night; but this process is not always convenient. With a little practice and patience it will be possible to focus directly during the night, especially when the operator is near sighted and can see, very close by, the feebly illuminated image upon the screen. In this case it is necessary to employ a screen that is as opaque as possible, so that too great a portion of the light shall not be absorbed; otherwise the result will be less satisfactory.

INSTINCT AND INTELLIGENCE IN ANIMALS.*

Biology is a science not only of the dead but of the living. The behavior of animals, not less than their form and structure, demands our careful study. Both are dependent on that heredity which is a distinguishing characteristic of the organic world. And in each case heredity has a double part to play. It provides much that is relatively fixed and stereotyped; but it provides also a certain amount of plasticity or ability to conform to the modifying conditions of the environment.

Instinctive behavior belongs to the former category; intelligent behavior to the latter. When a caterpillar spins its silken cocoon, unaided, untaught and without the guidance of previous experience; or when a newly mated bird builds her nest and undertakes the patient labors of incubation before experience can have begotten anticipations of the coming brood; we say that the behavior is instinctive. But when an animal learns the lessons of life, and modifies its procedure in accordance with the results of its individual experience, we no longer use the term instinctive, but intelligent. Instinct, therefore, comprises those phases of active life which exhibit such hereditary definiteness as fits the several members of a species to meet certain oft-recurring or vitally important needs. To intelligence belong those more varied modes of procedure which an animal adopts in adaptation to the peculiar circumstances of its individual existence. Instinctive acts take their place in the class of what are now generally known as congenital characters; intelligent acts in the class of acquired characters.

But the study of instinct and intelligence in animals opens up problems in a different field of scientific investigation. They fall within the sphere not only of biological but also of psychological inquiry. And in any adequate treatment of their nature and origin we must endeavor to combine the results reached by different methods of research in one harmonious doctrine. This involves difficulties both practical and theoretical. For those invertebrates, such as the insects, which to the naturalists present such admirable examples of instinctive behavior are animals concerning whose mental processes the cautious psychologist is least disposed to express a definite opinion. While the higher mammalia, with whose psychology we can deal with greater confidence, exhibit less typical instincts, are more subject to the disturbing influence of imitation, and, from the greater complexity of their behavior, present increased difficulties to the investigator who desires carefully to distinguish what is congenital from what is acquired.

Nor do the difficulties end here. For the term "instinct" is commonly, and not without reason, employed by psychologists with a somewhat different significance and in a wider sense than is necessary or even desirable in biology. The naturalist is concerned only with those types of behavior which lie open to his study by the methods of direct observation. He distinguishes the racial adaptation which is due to congenital definiteness from that individual accommodation to circumstances which is an acquired character. But for the psychologist instinct and intelligence comprise also the antecedent conditions in and through which these two types of animal activity arise. The one type includes the conscious impulse which in part determines an instinctive response; the other includes the choice and control which characterize an intelligent act.

When a spider spins its silken web, or a stickleback builds the nest in which his mate may lay her eggs, the naturalist describes the process and seeks its origin in the history of the race; but the psychologist inquires also by what impulse the individual is prompted to the performance. And when racial and instinctive behavior is modified in accordance with the demands of special circumstances, the naturalist observes the change and discusses whether such modifications are hereditary; but the psychologist inquires also the conditions under which experience guides the modification along specially adaptive lines. Each has his part to play in the complete interpretation of the facts. And each should consent to such definitions as may lead to an interpretation which is harmonious in its results.

In view, therefore, of the special difficulties attendant on a combined biological and psychological treatment of the problems of animal behavior, I have devoted my attention especially to some members of the group of birds in the early days of their life. And I shall therefore draw my examples of instinct and intelligence almost entirely from this class of animals. The organization and the sensory endowments of birds are not so divergent from those of man, with whose psychology alone we are adequately conversant, as to render cautious conclusions as to their mental states altogether untrustworthy; when hatched in an incubator they are removed from that parental influence which makes the study of the behavior of mammals more difficult; while the highly developed condition in which many of them first see the light of day affords opportunity for observing congenital modes of procedure under more favorable circumstances than are presented by any other vertebrate animals. Even with these specially selected subjects for investigation, however, it is only by a sympathetic study and a careful analysis of their behavior that what is congenital can be distinguished from what is acquired. For, from the early hours of their free and active life, the influence of the lessons taught by experience makes itself felt. Their actions are the joint product of instinct and intelligence, the congenital modes of behavior being liable to continual modification in adaptation to special circumstances. Instinct appears to furnish a ground plan of procedure which is shaped by intelligence to the needs of individual life. And it is often hard to distinguish the original instinctive plan from the subsequent intelligent modification.

It is not to my purpose so describe here in detail, as I have done elsewhere, the results of these observations. It will suffice to indicate some of the more salient facts. In the matter of feeding, the callow young of such birds as the jackdaw, jay or thrush instinctively open wide their beaks for the food to be thrust into their mouths. Before the eyes have opened, the external stimulus to the act of gaping would seem to be either a sound or the shaking of the nest when the parent bird perches upon it. Under experimental conditions, in the absence of parents, almost any sound, such as a low whistle, lip sound or click of the tongue, will set the hungry nestlings agape, as will also any shaking or tapping of the box which forms their artificial nest. And no matter what is placed in the mouth, the reflex acts of swallowing are initiated. But even in these remarkably organic responses the influence of experience soon makes itself felt. For if the material given is wrong in kind or distasteful, the effect is that the bird ceases to gape as before to the stimulus. Nor does it continue to open the beak when appropriate food has been given to the point of satisfaction. These facts show that the instinctive act is prompted by an impulse of internal origin, hunger, supplemented by a stimulus of external origin, at first auditory but later on, when the eyes are opened, visual. They show also that when the internal promptings of hunger cease, owing to satisfaction, the sensory stimulus by itself is no longer operative. And they show, too, that the diverse acts of gaping and swallowing become so far connected that the experience of distasteful morsels tends, for a while at least, to prevent further gaping to the usual stimulus.

With those birds which are active and alert soon after hatching, the instinctive acts concerned in feeding are of a different character. At first, indeed, the chick does not peck at grains which are placed before it; and this is probably due to the fact that the promptings of hunger do not yet make themselves felt, there being still a considerable supply of unabsorbed yolk. Soon, however, the little bird pecks with much, but not quite perfect, accuracy at small near objects. But here again experience rapidly plays its part. For if distasteful objects, such as bits of orange peel, are the first materials given, pecking at them soon ceases; and if this be repeated, the little bird cannot again be induced to peck, and may even die of starvation.

This makes it difficult to raise by hand some birds, such as plovers, whose natural food, in due variety, is not readily obtainable. It must be remembered, too, that under natural conditions the parent bird calls the young and indicates with her beak the appropriate food; and this appears to afford an additional stimulus to the act of pecking. Pheasants and partridges seem to be more dependent on this parental guidance than domestic chicks, and they are more easily reared when they have somewhat older birds as models whose pecking they may imitate. Passing allusion may here be made to a type of instinctive response in some respects intermediate between the upward gaping of the jay and the downward pecking of the chick. It is seen in the young moorhen, which pecks upward at food held above it and cannot at first be induced to take any notice of food on the ground. Under natural conditions it is fed by the parent, which holds the food above the little bird as it floats on the water.

We have then, in these simple instinctive acts, examples of behavior which is congenitally definite in type for each particular species; of actions which are the joint product of an internal factor, hunger, and an external factor, sensory impressions; of complex modes of procedure which subserve certain vital needs of the organism. It should be mentioned, however, that the relative definiteness of instinctive responses has been subjected to criticism from a psychological source. It has been urged that the nutritive instincts; the play instincts, the parental instincts, those of self-preservation and those concerned in reproduction, are so varied and multifarious that definiteness is the last thing that can be predicated of them. Varied and multifarious they are indeed; and each of the groups above mentioned contains many differing examples. But that is because we are dealing with comprehensive classes of instinctive behavior. The fact that the group of fishes includes organisms of such wide structural diversity as the salmon, the globe fish, the eel and the sole does not affect the fact that these species have a relatively definite structure each after its kind. It is only when we treat a group of fishes as if it were an individual fish that we are troubled by indefiniteness of structure. And it is only when we deal with a group of instincts, comprised under a class name, as if it were a particular instinctive act, that we fail to find that definiteness which to the naturalist is so remarkable.

From the physiological point of view, instinctive procedure would seem to have its origin in an orderly group of outgoing neural discharges from the central office of the nervous system giving rise to a definite set of muscular contractions. And this appears to have an organic basis in a congenital preformation in the nervous centers, the activity of which is called into play by incoming messages, both from internal organs in a state of physiological need and from the external world through the organs of special sense.

The naturalist fixes his attention chiefly on the visible behavior which is for him the essential feature of the instinctive act. But in view of the requirements of psychological interpretation it is advisable to comprise under the term instinct, in any particular manifestation of its existence, the net result of four things: first, internal messages giving rise to the impulse; secondly, the external stimuli which co-operate with the impulse to affect the nervous centers; thirdly, the active response due to the co-ordinated outgoing discharges; and fourthly, the message from the organs concerned in the behavior by which the central nervous system is further affected. Now I shall here assume, without pausing to adduce the arguments in favor of this view, that consciousness is stirred in the brain only by incoming messages. If this be so, the outgoing discharges which produce the behavior are themselves unconscious.

Their function is to call forth adaptive movements; and these movements give rise to messages which, so to speak, afford to consciousness information that the instinctive act is in progress. Hence I have urged that the instinctive performance is an organic and unconscious matter of the purely physiological order, though its effects are quickly communicated to consciousness in the form of definite messages from the motor organs. I have not denied that the stimuli of sight, touch, hearing and so forth also have conscious effects; I do not deny (though here I may have spoken too guardedly) that the initiating impulse of internal origin is conscious. In both these cases we have messages transmitted to the central office of the brain. What I have ventured to urge is that the consciousness of instinctive behavior, in its completed form, does not arise until further messages come in from the motor organs implicated in the performance of the act, lodging information at the central office concerning the nature of the movements.

Under the influence of the two primary groups of messages, due to impulse and to sensory stimulus, consciousness is evoked, and the brain is thrown into a state of neural strain, which is relieved by the outgoing discharge to the organs concerned in the instinctive behavior. It is this outgoing discharge which I regard as unconscious. But the actions which are thus produced give rise to a secondary group of incoming messages from the moving limbs. This it is which gives origin to the consciousness of instinctive behavior as such. And I regard it as psychologically important that these incoming messages are already grouped, so as to afford to consciousness information rather of the net results of movement than of their subsidiary details.

So much for our general scheme. If now we turn to the instinctive behavior concerned in locomotion, we find a congenital basis upon which the perfected activities are founded. There is no elaborate process of learning to walk on the part of the chick; ducklings and moorhens a few hours old swim with perfect ease when they are placed in water; these birds also dive without previous practice or preliminary abortive attempts; while young swallows, if their wings are sufficiently large and strong, are capable of short and guided flights the first time they are committed to the air. In these cases neither the internal impulse nor the sensory stimuli are so well defined as in the case of the nutritive activities. The impulse probably takes the form of an uneasy tendency to be up and doing, perhaps due to ill-defined nervous thrills from the organs of locomotion which are in need of exercise. The sensory stimuli are presumably afforded by the contact of the feet with the ground, or with the water, and by the pressure of the air on the wing surfaces. It is a curious fact that, if young ducklings be placed on a cold and slippery surface, such as that of a japanned tea tray, they execute rapid scrambling movements, suggestive of attempts to swim, which I have never seen in chicks, pheasants, or other land birds.

It will not be supposed that I claim for perfected locomotion, so admirably exemplified in the graceful and powerful flight of birds, an origin that is wholly instinctive and unmodified by the teachings of experience. Here as elsewhere instinct seems to form the ground plan of activities which intelligence moulds to finer and more delicate issues. This is the congenital basis on which is built the perfected superstructure. And if our opportunities for observation and our methods of analysis were equal to the task, we should be able to distinguish, in the development of behavior, the congenital outline from the shading and detail which are gradually filled in by the pencil of experience.

The difficulties which render this analysis at the best imperfect are, therefore, twofold. In the first place, intelligence begins almost at once to exercise its modifying influence; and in the second place, many instinctive traits do not appear until long after intelligence has begun its work. Much of the intelligent detail of the living picture is filled in before the instinctive outlines are complete. The term "deferred instincts" has been applied to those congenital modes of procedure which are relatively late in development. The chick does not begin to scratch the ground, in the manner characteristic of rasorial birds, till it is four or five days old; nor does it perform the operation of sand washing till some days later; the moorhen does not begin to flick its tail till it is about four weeks old; the jay does not perform the complex evolutions of the bath till it has left the nest and felt its legs, when the stimulus of water to the feet, and then the breast, seems to start a train of acts which, taken as a whole, are of a remarkably definite type.

The development of the reproductive organs brings with it, apart from the act of pairing, a number of associated modes of behavior—nest building, incubation, song, dance, display and strange aerial evolutions—which are presumably in large degree instinctive, though of this we need more definite evidence. For it is difficult to estimate with any approach to accuracy the influence of imitation. There seems to be no reason for doubting that, when an animal grows up in the society of its kind, it is affected by what we may term the traditions of its species, and falls into the ways of its fellows, its imitative tendency being subtly influenced by their daily doings. The social animal bears the impress of the conditions of its peculiar nurture. Its behavior is in some degree plastic, and imitation helps it to conform to the social mould.

The exact range and nature of the instinctive outline, independently of those modifications of plan which are due to the inherent plasticity of the organism, are there-

* A Friday evening discourse delivered at the Royal Institution, on January 28, by Prof. C. Lloyd Morgan and published in Nature

fore hard to determine. And if, as we have good grounds for believing, the growth of intelligent plasticity, in any given race, is associated with a disintegration of the instinctive plan, congenital adaptation being superseded by an accommodation of a more individualistic type, to meet the needs of a more varied and complex environment, the problems with which we have to deal assume an intricacy which at present defies our most subtile analysis.

We must now turn to the consideration of the manner in which individual accommodation, through the exercise of intelligence under the teachings of experience, is brought about. And it will be well to pave the way by adducing certain facts of observation.

Although the pecking of a young chick, under the joint influence of hunger and the sight of a small near object, would seem to belong to the instinctive type, the selection of appropriate food, apart from the natural guidance of the hen, seems to be mainly determined by individual experience. There is no evidence that the little bird comes into the world with anything like hereditary knowledge of good and evil in things eatable. Distasteful objects are seized with not less readiness than natural food, such as grain, seeds and grubs. The conspicuous colors of certain nasty caterpillars do not appeal to any inherited power of immediate discrimination so as to save the bird from bitter experience. They seem rather to serve the purpose of rendering future avoidance, in the light of this bitter experience, more ready, rapid and certain. Bees and wasps are seized with neither more nor less signs of fear than large flies or palatable insects. Nor does there seem to be any evidence of the hereditary recognition of natural enemies as objects of dread. Pheasants and partridges showed no sign of alarm when my dog quietly entered the room in which they were kept. When allowed to come to closer quarters, they impudently pecked at his claws. A two days' chick tried to nestle down under him. Other chicks took no notice of a cat, exhibiting a complete indifference which was not reciprocated. A moorhen several weeks old would not suffer my fox terrier to come near his own breakfast of sopped biscuit, but drove him away with angry pecks until the higher power supervened.

It is not, of course, to be inferred from these observations that such an emotion as fear has no place in the hereditary scheme, or that the associated acts of hiding, crouching, or efforts to escape do not belong to the instinctive type. I have seen little pheasants struck motionless, plovers crouch and moorhens scatter at the sound of a loud chord on the violin or of a shrill whistle. A white stoneware jug, placed in their run, caused hours of uneasiness to a group of birds, including several species. But there is no evidence that, in such cases, anything like hereditary experience defines those objects which shall excite the emotion. It is the unusual and unfamiliar object, especially after some days of active life amid surroundings to which they have grown accustomed; it is the sudden sound, such as a sneeze, or rapid movement, as when a ball of paper is rolled toward them, that evokes the emotion. Hence, if the parent birds are absent, the stealthy approach of a cat causes no terror in the breasts of inexperienced fledgelings. But when she leaps, and perhaps seizes one for her prey, the rest scatter in alarm, and for them the sight of a cat has in the future a new meaning.

The elementary emotions of fear, anger, and so forth stand in a peculiar and special relationship to instinct. At first sight they seem to take rank with the internal impulses which are the part determinants of instinctive behavior. The crouching of a frightened plover or landrail, the dive of a scared moorhen, result partly from the external stimulus afforded by the terrifying object, partly from the emotional state which that object calls forth. But in their primary genesis I am disposed—here following to some length the lead of Prof. William James—to assign to such emotions an origin similar to that of the consciousness which follows on the execution of the instinctive act. Assuming, as before, that consciousness owes its genesis to messages which reach the sensorium through incoming nerve channels, the sensory stimuli, afforded, let us say, by the sight of a terrifying object, do not seem, in the absence of inherited experience, capable of supplying messages which in themselves are sufficient to generate the emotion of fear.

Now, the well known accompaniments of such an emotional state are disturbances of the heart beat, the respiratory rhythm, the digestive processes, the action of the glands, and the tone of the minute blood vessels throughout the body. And all these effects are unquestionably produced by outgoing discharges from the central nervous system. But they are felt as the result of incoming messages, like vague and disquieting rumors, transmitted to the central office from the fluttering heart, the irregular breathing, the sinking stomach and the disturbed circulation. Is it not therefore reasonable to suppose that the emotion, in its primary genesis, is due to the effect on the sensorium of these disquieting messages? If this be admitted as a working hypothesis—and it cannot at present claim to be more than this—we reach, at any rate, a consistent scheme.

As primary messages to the central office of consciousness we have, on the one hand, those due to stimuli of the special senses, and, on the other hand, those resulting from the conditions of the bodily organs, taking the form of a felt craving for their appropriate exercise. These co-operate to throw the brain into a state of unstable equilibrium or neural strain, which is relieved by outgoing streams of nervous energy. And these in turn fall into two groups: first, an orderly set of discharges to the voluntary muscles concerned in behavior, and secondly, a more diffuse group of discharges to the heart, respiratory apparatus, digestive organs, glands and vascular network. In so far as these are outgoing discharges, they do not directly affect consciousness. But there quickly returns upon the sensorium an orderly group of incoming messages from the motor apparatus concerned in instinctive behavior, and a more indefinite group from the heart and other visceral organs. The former gives the well-defined consciousness of activity; the latter the relatively ill-defined feelings which are classed as emotional. But so swift is the backstroke from the body to the brain that, ere the instinctive behavior is complete, messages from the limbs, and, under the appropriate circumstances, from the heart—that is to say, of both instinctive and emotional origin—begin to be operative in consciousness, and the final stages of a given performance may be guided in the light of the experience gained during its earlier stages.

The exact manner in which consciousness exercises its guiding influence is a matter of speculation. Perhaps the most probable hypothesis is that the cerebral hemispheres are an adjunct to the rest of the central nervous system, and exercise thereon, by some such mechanism as the pyramidal tract in the human subject, a controlling influence. Given an hereditary ground plan of automatic and instinctive responses, the cerebral hemispheres may, by checking here and enforcing there, limit or extend the behavior in definite ways. In any case, from the psychological point of view, their action is dependent on three fundamental properties: first, the retention of modifications of their structure; secondly, differential results according as these modifications have pleasurable or painful accompaniments in consciousness; and thirdly, the building of the conscious data, through association, into a system of experience. The controlling influence of this experience is the essential feature of active intelligence. Or, expressed in the almost obsolete terminology of the older psychology, intelligence is the faculty through which past experience is brought to bear on present behavior.

Prof. Stout, whose careful work in analytical psychology is well known, has done me the service of criticising, in a private communication, my use of the phrase "past experience," urging that present experience is not less important in determining behavior than that which is past and which can only be operative through its revival in memory. The criticism is valid in so far as it shows that I have not been sufficiently careful to define what I mean by past experience. But I certainly had in mind, though I did not clearly indicate, the inclusion of what Mr. Stout regards as present experience.

My conception of "present," as I have elsewhere described it, is that short but appreciable period of time, occupying only some small fraction of a second, which is comprised in the fleeting moment of consciousness. All anterior to this, if it were but a second ago, I regard as past—past, that is to say, in origin, though still operative in the limited field of the present moment. When we are reading a paragraph and near its close, the net result of all that we have read in the earlier sentences is present to influence the course of our thought. But the very words—"all that we have read"—by which we describe this familiar fact, imply that the guiding experience originated in a manner which demands the use of the past tense. Still I am none the less grateful to Mr. Stout for indicating what to many may have seemed a serious omission in my interpretation. Suffice it to say that if we include under the phrase "present experience" the occurrences of five minutes, or even of five seconds ago (all of which I regard as past), I most fully agree that present experience (in this sense) exercises a most important guiding influence.

We have distinguished four classes of messages affecting consciousness in the central office of the sensorium; first, stimuli of the special senses; secondly, internal cravings; thirdly, motor sensations due to bodily activity; and fourthly, emotional states. These are combined in subtile synthesis during the growth of experience, and are associated together in varied ways. Into the manner in which experience grows we cannot enter here. It will be sufficient to indicate very briefly the effects of this growth on the behavior of animals in the earlier stages of their life. This may be considered from a narrower or from a broader standpoint. In the narrower view we watch how, within the field of a widening synthesis, the particular associations are formed. We see how, within experience, the taste and appearance of certain caterpillars or grubs become so associated that for the future the larva is left untouched. Or we see how the terrible pounce of the cat has become so associated with her appearance as thenceforth to render her an object of fear to enlightened sparrows. But of the physiological mechanism of association we know little.

There is a familiar game in which a marble is rolled down an inclined board at the bottom of which are numbered compartments. The lower part of the board is beset with a series of vertical pins so arranged that the marble rebounding from one to another pursues a devious course before it reaches its destination. But if we tie threads from pin to pin we may thus direct the course of the marble along definite lines. Now the brain may be roughly likened to a set of such pins, and the marble to an incoming nerve current. The congenital structure is such that a number of hereditary threads connect the pins in definite ways, and direct the discharge into appropriate channels. But a vast number of other threads are acquired in the course of individual experience. These are the links of association which direct the marble in new ways. Observation of behavior can only give us information that new directing threads have been introduced. The psychology of association can only indicate which pins have been connected by linking threads. Even such researches as those of Flechsig can at present do no more than supplement the psychological conclusion by general anatomical evidence. Of the details of brain modification by the formation of association fibers we are still profoundly ignorant.

Nor when we turn from the narrower to the wider point of view are we in better case. We are forced to content ourselves with those generalities which are the makeshift of imperfect knowledge. Still, even such generalities are of use in showing the direction in which more exact information is to be sought. And we can, perhaps, best express the net result of acquired modification of brain structure by saying that every item of experience makes the animal a new being with new reactive tendencies. The sparrows, which yesterday were unaffected by the stealthy approach of the cat, garrulously scatter to day because they are not the same simple minded sparrows that they were. The chick comes into the world possessed of certain instinctive tendencies—with certain hereditary directing threads. But at the touch of experience its needs are modified or further defined. New connecting threads are woven in the brain. On the congenital basis has been built an acquired disposition. The chick is other than it was, and reacts to old stimuli with new modes of behavior.

In its early days the developing animal is reading the paragraph of life. Every sentence mastered is built into the tissue of experience, and leaves its impress on the plastic yet retentive brain. By dint of repetition, the results of acquisition become more and more firmly ingrained. Habits are generated; and habit becomes second nature. The organism which to begin with was a creature of congenital impulse and reaction becomes more and more a creature of acquired habits. It is a new being, but one with needs not less imperious than those with which it was congenitally endowed.

All of this is trite and familiar enough. But it will serve its purpose if it help us to realize how large a share acquired characters take in the development of behavior in the higher animals, and how fundamentally important is the plasticity of brain tissue, and its retentiveness of the modifications which are impressed on its yielding substance.

Such being the relations of intelligence and instinct in the individual, what are their relations in the evolution of the race? Granting that instinctive responses are definite through heredity, how has this definiteness been brought about? Has it been through natural selection? Or are the acquired modifications of one generation transmitted through heredity to the next? Is instinct inherited habit? Darwin, who wrote before the transmission of acquired characters was seriously questioned, admitted both. And Romanes, to whose ever kindly sympathy I am deeply indebted, still adhered to this view in spite of modern criticism. There is not much in my own observational work which has any decisive bearing on the question. But there are one or two points which are perhaps worthy of consideration. The part played by acquisition in the field of behavior is the establishment of definite relations between particular groups of stimuli and adaptive responses. If this be so, and if acquired modifications of brain structure be transmitted, we might reasonably expect that the sight of a dog would have a similar effect on young pheasants to that which it has on their parents. But this does not appear to be the case. Again, one might reasonably expect that the sight of water would evoke a drinking response in recently hatched birds, just as the sight or scent of a Yucca flower excites a definite response in the Yucca moth. But here, too, this is not so.

Thirsty chicks and ducklings seem to be uninfluenced by the sight of water in a shallow tin. They may even run through the liquid and remain unaffected by its presence. But if they chance to peck at a grain at the bottom of the tin, or a bubble on the water, as soon as the beak touches the liquid, this stimulus at once evokes a drinking response again and again repeated. Why does the touch of water in the beak excite a congenital response, while the sight of water fails to do so? I believe it is because under natural conditions the chicks peck at the water in imitation of the mother, who thus shields them from the incidence of natural selection. Under these circumstances there is no opportunity for the elimination of those who fail to respond at the mere sight of water, and consequently no selective survival of those who do thus respond.

But though the hen can lead her young to peck at the water, she cannot teach them the essential movements of beak, mouth and gullet which are necessary for the complex act of drinking. In this matter she cannot shield them from the incidence of natural selection. Those which, on pecking the water, failed to respond to the stimulus by drinking would assuredly die of thirst and be eliminated. The rest would survive and transmit the congenital instinctive tendency. Thus it would seem that when natural selection is excluded a special mode of behavior has not become congenitally linked with a visual stimulus; but, when natural selection is in operation, this behavior has become so linked with a touch or taste stimulus in the beak. Similarly in the case of the pheasants and the dog. The parent birds warn the young of his approach, and thus prevent the incidence of natural selection; hence there is no instinctive response to the sight of a terrier.

No doubt there are many cases of complex behavior, seemingly instinctive, which are difficult to explain by natural selection alone, and which have the appearance of being due to the inheritance of acquired habits. I have, however, elsewhere suggested that acquired modifications may, under the conditions of natural selection, foster the development of "coincident" variations of like nature and direction, but having their origin in the germinal substance. But into a consideration of this hypothesis I cannot here enter. Without assuming a dogmatic attitude, I am now disposed to regard the direct transmission of acquired modes of behavior as not proved.

Thus we come back to the position, assumed at the outset, that heredity plays a double part. It provides, through natural selection or otherwise, an outline sketch of relatively definite behavior, racial in value; it provides also that necessarily indefinite plasticity which enables an animal to acquire and to utilize experience, and thus to reach adaptation to the circumstances of its individual life. It becomes, therefore, a matter of practical inquiry to determine the proportion which the one kind of hereditary legacy bears to the other. Observation seems to show that those organisms in which the environing conditions bear the most uniform relations to a mode of life that is relatively constant are the ones in which instinct preponderates over intelligent accommodation; while those in which we see the most varied interaction with complex circumstances show more adaptation of the intelligent type. And the growth of individual plasticity of behavior, in race development, would seem to be accompanied by a disintegration of the definiteness of instinctive response, natural selection favoring rather the plastic animal capable of indefinitely varied accommodation than the more rigid type whose adaptations are congenitally defined.

I have dealt, it will be observed, only with the lower phases and earlier manifestations of intelligence. Its higher development, and the points in which it differs from the more complex modes of human procedure, offer a wide and difficult field for careful observation and cautious interpretation. I have recently attempted further investigations in this field; but they concern rather the relation of intelligence to logical thought than that of instinct to intelligence, which forms the subject of this discourse.

AN ELECTRIC CURVE TRACER.

FOR DELINEATING THE FORMS AND PHASES OF PERIODIC ELECTRIC QUANTITIES, VIZ., ELECTRIC CURRENTS, ELECTROMOTIVE FORCES, ELECTRIC POWER AND MAGNETIC INDUCTION, ALSO FOR TRACING HYSTERESIS CURVES.*

By Prof. EDWARD B. ROSA, Ph.D.

UNDOUBTEDLY one of the most interesting and fruitful methods of study and investigation of alternating current phenomena is the tracing of the forms and phases of alternating current waves. Without these curves one can gain only a very inadequate idea of the inner working of a dynamo, motor or transformer; and, considering the rapid multiplication of alternating current apparatus, both of single phase and multiphase varieties, it is evident that the field of usefulness of alternating current diagrams, already very great, is constantly increasing.

The practicability of this method of investigation and testing has been seriously limited by the great labor of obtaining the curves, and the insufficient accuracy of the curves when obtained. To find and plot a dozen or two points and then draw a smooth curve through them and call it the curve of current or electromotive force will sometimes answer, for want of something better. But it is often unsafe to infer very much from such a curve. What is wanted is so large a number of points as to be practically equivalent to a continuous line, marking exactly the fluctuations of the current. And when several such related curves have been drawn to scale on a single sheet, showing the forms, phases and relative amplitudes of the currents and electromotive forces (and, perhaps, also the magnetizations and power waves) which are concerned in the operation of a given machine or system, we have a beautiful picture of what in algebraic language merely is not very attractive.

Various methods of obtaining these curves have been employed. An instantaneous contact maker, connected with the armature of the dynamo, is generally used. The disk of the contact maker revolves with the same angular speed as the dynamo, and a brush which rests upon its edge makes contact once in every revolution with a knife edge let into the disk. As the brush is advanced step by step, contact is made at later instants in the phase; but while the brush is at rest in any position, the current and electromotive force return to the same values at each successive instant of contact. The value of current at the instant of contact (Fig. 1) is determined by measuring the difference of potential of the terminals, A B, of a known resistance through which the current flows. This potential difference is sometimes ascertained by joining a condenser, C (Fig. 1), to A B, by a switch, N, through the contact maker,

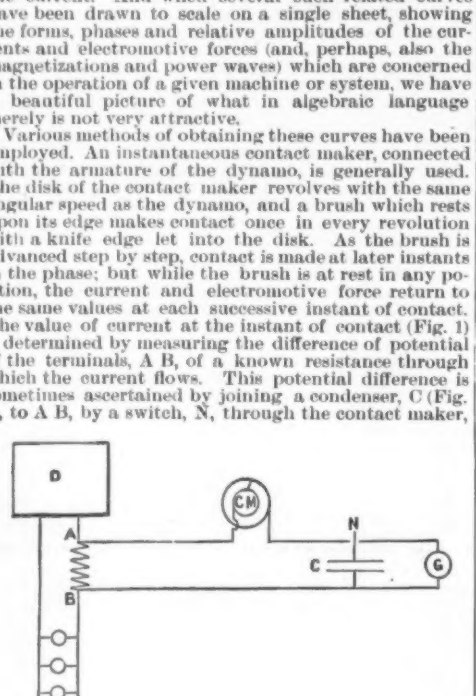


FIG. 1.

M, and then discharging the condenser through a ballistic galvanometer. Under these circumstances, the charge of the condenser will be proportional to the difference of potential between A and B at the instants of contact in M, and this in turn is proportional to the corresponding instantaneous value of the current flowing from the dynamo. The position of the contact brush is then advanced, the condenser is again charged and discharged, and a second value of the current, corresponding to the new phase of contact, is obtained; or an electrometer may be substituted for the galvanometer, and its deflection read at each setting of the brush. In this way a number of points may be obtained and plotted out on cross section paper, and a curve drawn through them. But if the number of points is sufficient to give an accurate curve, the time and labor required are very great. Moreover, it may be impossible to keep the circumstances of the circuit constant for so long a time, and the later ones of a set of curves will not, therefore, correspond with the first.

THE POTENTIOMETER METHOD.

In the following potentiometer method readings can be taken more rapidly, as well as more accurately, than by using a ballistic galvanometer or electrometer. A hard rubber rod, anywhere from 60 to 100 centimeters in length, is wound with one layer of copper or German silver wire. If the wire is bare, the rod may be threaded in a lathe, and this will secure insulation and uniformity of winding; if insulated, the insulation may be removed along the top side, so that a sliding contact piece passing over it will always make good contact (Fig. 2). A current from two or three storage cells flows through this potentiometer coil, and by means of a voltmeter and adjustable resistance, the difference of potential of the ends of the coil is maintained constant. The instantaneous difference of potential at the terminals of A B is now measured by matching it against the known difference of potential of a part of the coil, N O. The point, Q, at the middle of N O, is joined through a galvanometer to B, while P, a sliding contact, is joined through the revolving contact maker, M, to the point, A. When the differences of potential at A B and P Q are equal, there is no deflection of the galvanometer. P is therefore moved in the direction indicated by the galvanometer deflection, until the latter is reduced to zero. The distance, P Q, is then proportional to the current through A B, and knowing the difference of potential, P O, and the resistance, A B, we determine at once the precise value of the current. The brush of the contact maker may then be advanced, when the new setting of P will give the new instantaneous value of the current through A B. The galvanometer should be dead beat, quick and fairly sensitive. A d'Arsonval meets the conditions admirably, and indicating, as it does, the direction in which P must be moved to secure a balance, is superior to a telephone, which could be used. When the current is flowing from A to B, A will be at the higher potential and P will fall somewhere on the left of Q. If, however, the current is from B to

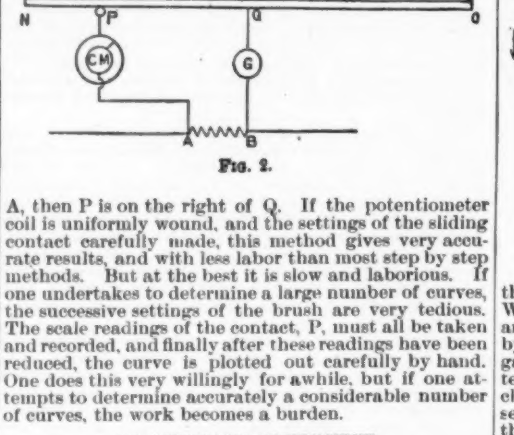


FIG. 2.

A, then P is on the right of Q. If the potentiometer coil is uniformly wound, and the settings of the sliding contact carefully made, this method gives very accurate results, and with less labor than most step by step methods. But at the best it is slow and laborious. If one undertakes to determine a large number of curves, the successive settings of the brush are very tedious. The scale readings of the contact, P, must all be taken and recorded, and finally after these readings have been reduced, the curve is plotted out carefully by hand. One does this very willingly for awhile, but if one attempts to determine accurately a considerable number of curves, the work becomes a burden.

AN AUTOMATIC INSTRUMENT.

It was while engaged in this kind of work nearly two years ago that I undertook to devise an apparatus that should reduce the labor and increase the speed of drawing electric curves. The apparatus which is shown in Figs. 3 and 4 is the outcome of this endeavor. The most laborious parts of the operation, including setting the contact brush, are done automatically by the machine, and the work of several hours may be done in as many minutes. The measurements are made by the foregoing potentiometer method, the results are simultaneously plotted by the machine more accurately than they could be plotted by hand, and a curve being obtained in a few minutes, the speed, voltage and other circumstances may be maintained more nearly constant than would be possible when the observations extend over several hours. For these reasons the curves obtained are of unprecedented accuracy.

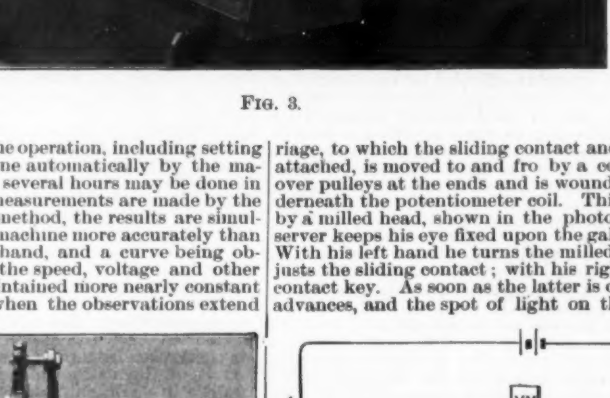


FIG. 3.

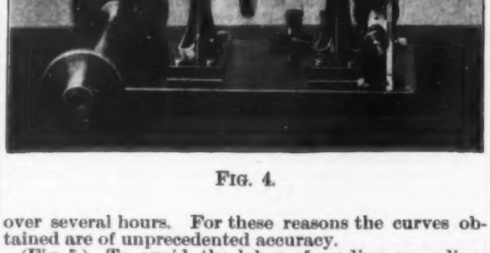


FIG. 4.

(Fig. 5.) To avoid the labor of reading, recording, reducing and plotting the various values of the current and electromotive force, a pantograph is employed to print the curves automatically as the settings are made. The pantograph has one end fixed at P' and the other end fixed to the carriage to which is attached the movable contact, P. On an extra bar the printing electromagnet, F, is carried, and as the carriage and sliding contact, P, move to and fro along the spiral, F moves to and fro in a parallel line at a reduced speed. The distance of F from its zero position is, therefore, always proportional to P Q, that is, to the value of the current at the instants of contact. Hence by printing a point directly under F upon a sheet of paper carried by a cylinder or plate, the instantaneous value of the current is permanently registered. This is done by closing a key, when an electric current passes through F and throws a steel point down upon a typewriter ribbon, printing a dot on the paper beneath it. This current also passes through an electromagnet on the contact maker and another on the record cylinder, attracting

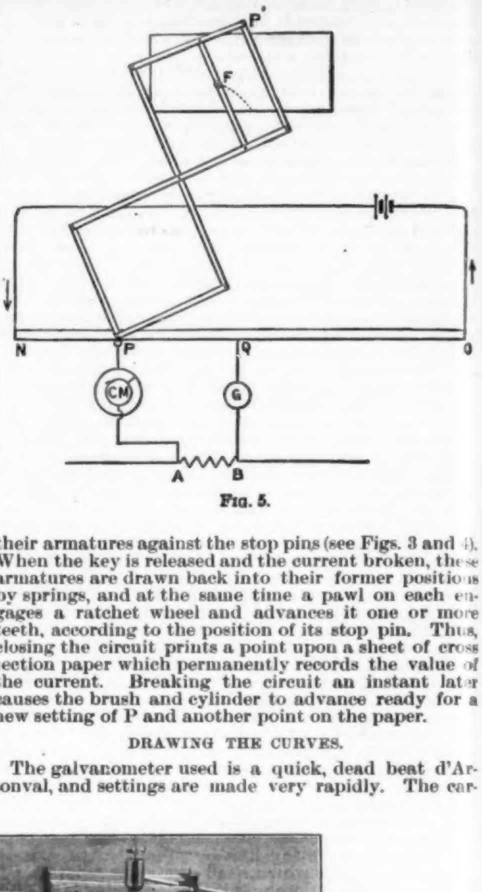


FIG. 5.

their armatures against the stop pins (see Figs. 3 and 4). When the key is released and the current broken, these armatures are drawn back into their former positions by springs, and at the same time a pawl on each engages a ratchet wheel and advances it one or more teeth, according to the position of its stop pin. Thus, closing the circuit prints a point upon a sheet of cross section paper which permanently records the value of the current. Breaking the circuit an instant later causes the brush and cylinder to advance ready for a new setting of P and another point on the paper.

DRAWING THE CURVES.

The galvanometer used is a quick, dead beat d'Arsonval, and settings are made very rapidly. The carriage, to which the sliding contact and pantograph are attached, is moved to and fro by a cord which passes over pulleys at the ends and is wound over a drum underneath the potentiometer coil. This drum is turned by a milled head, shown in the photograph. The observer keeps his eye fixed upon the galvanometer scale. With his left hand he turns the milled head, and so adjusts the sliding contact; with his right he works the contact key. As soon as the latter is opened the brush advances, and the spot of light on the scale goes off

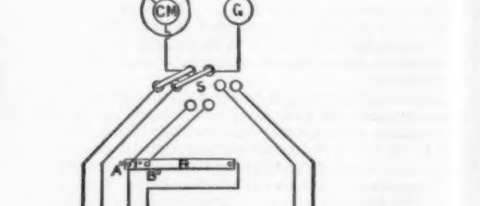


FIG. 6.

the zero, to the right or left, according as the current has decreased or increased. The contact, P, is immediately moved in the same direction until the spot of light is brought back to zero, when the circuit is again closed, a point is printed, the brush advances, the spot of light again goes off the zero, etc. Twenty points a minute can be printed after some practice.

A second electromagnet mounted on the carriage prints a pencil point (if desired) on a strip of paper

* This electric curve tracer formed the subject of a communication by Prof. Rosa to the British Association.—Published in the Physical Review.

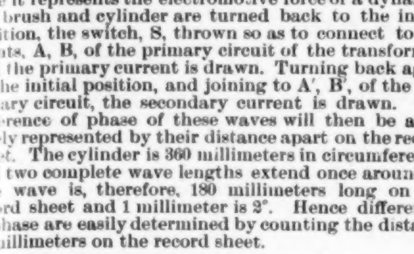
whenever the first one prints a point on the record sheet. Duplicate curves can then be printed by setting the pencil point over these dots, without running the dynamo, and curves originally printed on separate sheets can be combined on the same sheet. Typewriter ribbons of different colors are used for different curves, so that the curves are easily distinguished, even though they be considerably interlaced. The teeth of the two ratchet wheels are numbered, so that the contact brush and record cylinder can be set at any particular position desired. In drawing a curve, their initial positions are noted (Fig. 6), and when the curve is finished (suppose it represents the electromotive force of a dynamo), the brush and cylinder are turned back to the initial position, the switch, S, thrown so as to connect to the points, A, B, of the primary circuit of the transformer, and the primary current is drawn. Turning back again to the initial position, and joining to A', B', of the secondary circuit, the secondary current is drawn. The difference of phase of these waves will then be accurately represented by their distance apart on the record sheet. The cylinder is 360 millimeters in circumference, and two complete wave lengths extend once around it. One wave is, therefore, 180 millimeters long on the record sheet and 1 millimeter is 2°. Hence differences of phase are easily determined by counting the distance in millimeters on the record sheet.

THE SCALE OF THE CURVES.

The non-inductive resistances, A B, and A' B', are adjustable, so that any given current may be drawn to a suitable scale, which is chosen in advance. The potentiometer coil is 80 millimeters long, and the pantograph reduces the scale in the ratio of 5 to 1. Hence, if the difference of potential of the ends of the coil is 4 volts, 1 volt corresponds to 20 centimeters on the coil or 4 centimeters on the record sheet. If the resistance of A B is $\frac{1}{4}$ ohm, 4 amperes would give a potential difference of 1 volt, and this would be plotted on the paper as an ordinate 4 centimeters high. Thus the scale of the curve would be 1 ampere per centimeter. If the resistance of A B is $\frac{1}{8}$ ohm, the scale would be 2 amperes per centimeter; if $\frac{1}{40}$ ohm, 10 amperes per centimeter, etc. If the cross section paper is (Figs. 7 and 8) ruled in inches and tenths or twentieths, as is the case with what I have generally used, the scale works out similarly: 80 centimeters equal 31·5 inches; one-fifth of this is 6·3 inches, the extreme range on the paper. Let the difference of potential of the ends of the potentiometer coil be maintained at 6·3 volts. Then 1 volt on the coil corresponds to 1 inch on the paper. If A B has a resistance of $\frac{1}{4}$ ohm, the scale of the curve is 4 amperes per inch; if $\frac{1}{8}$ ohm, 8 amperes per inch; if $\frac{1}{40}$ ohm, 40 amperes per inch, etc.

SERIES AND SHUNT RESISTANCES.

A convenient form of adjustable resistance for A B and A' B' is illustrated in Figs. 7 and 8. Four resist-



FIGS. 7 AND 8.

ances are so arranged that, by dropping connecting links into mercury cups, any one or more of them may be used in parallel. Fig. 8 shows a plan of the top of one of the resistance boxes. Four mercury cups, C, D, E, F, are the terminals of the four resistances (the other ends of which unite at the binding post, A), and they may be joined to the central cup, G, by copper links. The resistances are 1, $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$ ohm respectively, and hence the current would be 1, 2, 5 and 10 amperes per volt difference of potential of the terminals, these numbers expressing the conductance of the several coils. From what has been said, it is evident that the scale of the curves would be 1, 2, 5 or 10 amperes per inch, according to which of the four resistances was used. If the first and second were used together, the scale would be 3 amperes per inch; if the first and third, 6 amperes per inch: if all were used at once, 18 amperes per inch. For heavier currents smaller resistances of greater carrying capacity would be used. The small binding posts, a b, are connected with the large posts, A B, as indicated, and from them wires pass off to the switch, S, of the Fig. 6. The resistance of A B may be altered so as to have the current drawn to a suitable scale without breaking the circuit, and the scale is read off directly without any other numerical calculations than adding the conductances, as already indicated.

If the non-inductive resistance, R, is 2,000 ohms, and r, a part of it, is 20 ohms, that is, $\frac{1}{100}$ of the total, then, since the difference of potential of A'' B'' is drawn out on the second sheet on a scale of 1 volt per inch, the scale of the electromotive force curve will be 100 volts per inch. If A'' B'' is 10 ohms, then the scale of the curve is 200 volts per inch, etc. In a similar manner power curves, magnetic induction curves and hysteresis curves are drawn to a known scale.

DERIVED CURVES.

Magnetic induction curves are not drawn directly, but are derived from the electromotive force curves. Writing down from the curve the instantaneous values of the electromotive force for a single period, and summing them up, we get a series of values of the induction which are laid off upon a strip of paper. This is placed upon the curve tracer precisely as when duplicating curves, and the curve of magnetic induction is printed upon the record sheet, showing its proper phase relation to the other curves. Its position is determined by the consideration that the induction is stationary, usually a maximum, when the electromotive force is zero.

Hysteresis curves are derived from the curves of current and magnetic induction already drawn, and include the eddy current loss with the hysteresis loss. The current which has magnetized the iron under investigation is printed on a narrow strip of paper and attached to the end of the record cylinder at right angles to its position when printed. Two persons are required. One sets the pointer attached to the carriage upon the first point of the strip of the induction curve, while the other observer, taking the ratchet wheel in his left hand, sets the cylinder so that the first point of the current curve comes directly under a fixed line above the cylinder. A point is then printed on the record sheet when the two observers advance to the second points, print a second dot, etc.

POWER CURVES.

Power cruves, like curves of current and electromotive forces, are drawn directly while the generator is running. A second solenoidal coil, 80 centimeters in length, is mounted in the instrument parallel with the first. It has a sliding contact propelled by a rack and pinion, shown in the figure. This second coil is of German silver wire, and is in series with a larger non-inductive resistance, R; it carries a current proportional to the electromotive force, the terminals, TT', being joined to the dynamo, or to the terminals of the circuit to which the power curve is to be drawn (Fig. 9). In-

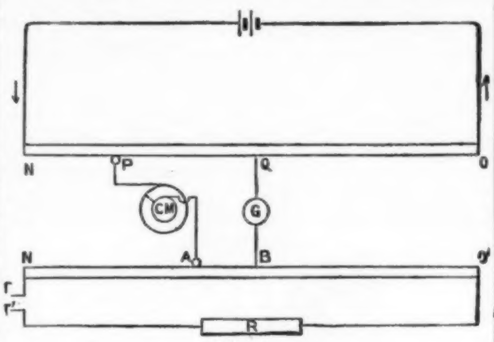


FIG. 9.

stead of using a fixed resistance, A B, as in other cases, the resistance whose terminals are A B is varied, being in each case proportional to the current at the instant of contact. This is effected by having B fixed at the middle of N' O', and then setting A by the points printed by the extra electromagnet on the strip of paper when the current curve was drawn. When the current is negative, A is on the right hand side of B. The difference of potential between A B is proportional to the distance, A B, and also to the current passing through the coil, N' O'. Since the former is proportional to i (the current) and the latter is proportional to e (the electromotive force), the difference of potential of A B (and therefore of P Q) is clearly proportional to the product, which is the instantaneous power. Advancing the contact brush gives contact at a later instant of phase, when both i and e have changed. Setting the contact, A, to the new value of the current, and moving P until a new balance is obtained, a second point of the power curve is obtained. Obviously the power curve will cut the zero line whenever the current is zero (for then A comes to B), and also whenever the electromotive force is zero (for then there is no current in N' O'). It has a positive loop when current and electromotive force are both positive or negative and a negative loop when only one is positive. Thus are power curves accurately drawn to a predetermined scale, and the labor of multiplying the corresponding ordinates of current and electromotive force is avoided.

THE CONTACT MAKER.

Much of the success of the curve tracer depends upon the contact maker, and great care has been taken in perfecting it. The shaft of the contact maker is joined to the shaft of the dynamo (or perhaps, to a synchronous motor) by a coupling shown in the figure. At the nearer end of the connecting rod the latter is joined to the plate (which latter is fastened rigidly to the shaft by a collar and set screw, as shown) by a flexible steel diaphragm, so that perfect alignment of the contact maker and dynamo is not necessary. At the further end the plate carries two steel pins, one at its center and one near its edge, which fit loosely into two corresponding holes in a plate clamped to the end of the dynamo shaft. Thus the end play of the armature is not communicated to the contact maker, and when the latter is clamped to a firm base, the shaking and jarring of the dynamo are not transmitted to the contact maker. Two oil cups carry a good supply of oil, and the shaft carrying the hard rubber disk runs as smoothly as a top, hour after hour if desired, with very little attention.

The galvanometer current, which flows momentarily when the knife edge in the hard rubber disk passes under the contact brush, enters at the binding post, which is seen behind the left-hand oil cup, passes through a brush to a slip ring on the left of a large disk, and from there to a steel knife edge or contact piece let into the edge of the hard rubber disk. Passing to the brush and insulated brush holder, the current flows to a second slip ring, and away by a second brush and binding post on the right. The mechanism which advances the brush can be understood by comparing Figs. 3 and 4. The teeth of the ratchet and large gear are numbered, so that the initial position of the brush can be recorded, and the brush returned to the same position for the beginning of successive curves. The milled head on the end of the spindle which carries the ratchet wheel and pinion enables one to set the brush quickly by hand at any desired place. The two binding posts seen at the back of the base are the terminals of the coil of the electromagnet which operates the ratchet.

Mexico is richly endowed with precious stones. The opals of Queretaro, San Juan del Rio and Tequisquapan are famous for their changing fires. They are found in crusts on the calcareous rocks, which are easy to work, and also in the granite, which has to be blasted, and this often breaks the gems. The opal beds are seldom more than ten or twelve feet below the surface.

REPORT ON THE BUBONIC PLAGUE IN BOMBAY.*

SUCH a vast amount of interest has been taken in the progress of the plague in Bombay that the report issued by Brigadier-General Gatacre will be received with eagerness by the medical and lay communities alike. We naturally review it mainly from a professional point of view, and taken as a whole we think that the chairman of the committee, together with his colleagues, may congratulate themselves upon having drawn up an able and complete account of the plague in so far as they were officially connected with it. In their report they have confined themselves almost entirely to the period between March 17 and June 30, 1897. It follows therefore that from this report we learn but little about the epidemic when it was at its height in January of last year and nothing as regards its progress after the end of June. It is difficult indeed to gather whether the malady had been checked or was still raging were it not for a reference to "the decline" as a reason for a reduction in the plague pay of the non-commissioned officers and soldiers employed by the committee. With these exceptions, however, the report is most admirably drawn up and for medical readers especially contains a mass of interesting and readable information.

Chapter I is headed "General Report," and includes a brief description of the operations conducted by the municipal authorities up to the time when the committee was appointed. Great difficulty was at this time experienced in arriving at the true plague mortality, the chief being the dread entertained by all classes of the population of being removed to hospital and the fear of having their houses invaded by a disinfecting staff.

On October 6, 1896, the municipal commissioner issued a proclamation to the effect that all cases were to be segregated, their houses disinfected, by force, if necessary, and their sick to be taken to hospital. This order was unfortunately badly, or rather insufficiently, worded and raised a storm of protest. It was not explained that the relatives of the patient would be allowed to attend him or that the prejudices of the various castes in the matter of food, etc., would be respected. Lord Sandhurst's letter to General Gatacre was a great contrast to this. He explained that measures were to be taken to suppress and prevent the spread of bubonic plague. These measures should comprise an organization for: (1) the discovery of all cases of plague; (2) the treatment of all cases in hospital; and (3) the gradual segregation as far as possible of the probably affected. The letter continues: "These are the objects to the attainment of which your energies should be directed. I am sure I need not do more than indicate that in all cases of obstinacy or misunderstanding on the part of those whom it is our endeavor to benefit, persuasion and gentleness should be used; that the privacy of women should be disturbed as little as possible and only by women, and that the caste and religious usages of the people should be treated with all consideration."

The organization and disposition of medical officers is then given and explained by means of colored plans.

The instructions given to the nursing staff are also detailed and special attention is rightly drawn to the courageous and self-denying conduct of the All Saints' Sisters, Mazagon, who nobly carried out a great portion of the nursing duties, the general supervision of the nurses being undertaken by the Reverend Mother Superior of that community. The Bandora Sisters (Filles de la Croix) also rendered most valuable service. The difficulties of bringing the Mahometans to reason in reference to segregation and hospital treatment are then described and the measures adopted for their removal duly recorded. We must not forget to note that M. Haffkine in his minute attached to the report of the Mauser Committee expressed his opinion that the measures of disinfection carried out by the health officer before the commission commenced its work "were in accordance with the best recognized principles of sanitation and were not in need of alteration."

In Chapter II the distribution of the hospitals with the staff attached to each is detailed, together with a statistical, and in most cases a careful, medical report of the cases treated in each. These reports are most valuable, and in a separate volume carefully prepared charts are recorded giving the temperature curve, pulse and respirations in a very large number of cases. To those who are interested in the clinical characters of the outbreak this chapter will yield most valuable information.

Chapter III gives a very excellent summary of the "Medical Aspect of Plague," derived from the views expressed by the medical officers working under the committee. The forms and types of plague are distinguished by some into simple bubonic and pneumonic plague only, by others as plague (with buboes and without buboes), all the variations in these two forms being grouped under symptomatic evidences of complications associated with one or other form. Reviewing opinions generally, the following is given as a rational classification of forms of plague:

1. With enlarged glands (gravity according to symptoms and severity of attack).	Femoral. Inguinal. Axillary. Cervical. Tonsillar.
2. Without enlarged glands (almost always fatal).	Septicæmic. Pneumonic. Mesenteric, enteric, or gastro-intestinal. Nephritic. Cerebral.

The signs and symptoms of these various forms are then given, followed by a section on "Ready Method of Diagnosing Plague."

With regard to treatment the report states: "It is difficult to recommend any particular line of treatment with confidence, for it is often seen that a plan of treatment which succeeds in one case totally fails in another. It may be shortly summed up as nutritive, stimulant, antiseptic, antipyretic and local." Calomel was largely used, as were the ice bag and ice packing for hyperpyrexia, the bath being considered dangerous, as "the

* Report on the Bubonic Plague in Bombay. By Brigadier-General W. F. Gatacre, C.B., D.S.O., chairman, Plague Committee, 1896-97. With plans. Bombay, 1897. Printed at The Times of India steam press.

danger of sudden failure of the heart's action makes it imperative to avoid movement on the part of the patient as much as possible."

Considerable interest attaches to the reports of M. Haffkine and Dr. Yersin's methods of treatment, neither of which, however, were attended with the success which had been hoped for, but this failure need not in any way prevent further investigations being made on the same lines.

M. Haffkine adopted his well known method of cultivating the pathogenic bacillus in suitable media, killing the germs by heat and then injecting increasing quantities of the soluble toxins whereby mild reactionary symptoms of plague were produced. Dr. Yersin injected the antitoxin prepared from the serum of an immunized horse. The next five chapters describe the methods employed for the detection of cases of plague and for the prevention of the spread of the disorder, and include "land traffic inspections," "sea traffic inspection and observation camps," house-to-house visitation and disinfection, and the report by Veterinary Major J. Mills, A.V.D., on the Pandora slaughter house. A list of foreign scientific missions is then given and reports follow on the outbreak of plague in the Kolaba and Cutch Mandvi districts.

Chapter XII is an excellent summary of the views of the commission. Reference is made to those who lost their lives while working under the committee. These are remarkably few in number, a matter of high praise to those who had the superintendence of the preventive measures adopted by the staff for their own protection. At Cutch Mandvi Nurse Herne died after only a few days' illness, as did also Sister Elizabeth (Fille de la Croix), who nursed at the Government Hospital at Mahim. Two hospital assistants caught the disease, one of whom recovered. Three military ward orderlies are recorded as having died of the disease contracted while engaged in hospital work.—Lancet.

A REPRESENTATION OF THE CRUCIFIXION.

NOT since the discovery of the "Logia" containing some unpublished sayings of Christ has anything been found which compares in interest to the student of Christian archæology with the alleged discovery in the Palace of Tiberius, on the Palatine Hill, in Rome, of a "graffito" representing the Crucifixion. A "graffito," it may be said, is a picture or inscription scratched on the wall. Making graffiti was a habit to which the Romans were very much addicted, and owing to it we have been fortunate in obtaining much information which we could not have obtained in any other way.

A distinguished archæologist, Prof. Orazio Marucchi, the director of the Egyptian Museum of the Vatican, has devoted himself for many years to the study of epigraphy, and now he has brought himself into great prominence owing to his discovery of the graffito referred to. The picture is scratched on the level of the ground close by the angle of one of the passages which lie under the structures adjoining the Bridge of Caligula, in the immediate neighborhood of the Clivus Victoriæ. The building is really a gallery made by Caligula to connect the Palace with the Forum. One reason that even the archæologist has great difficulty in making out the topography of the Palatine is that it is covered with a vast series of substructures which supported the palaces and which afforded rooms and passageways for the servants and especially the soldiers.

A GRAFFITO OF THE CRUCIFIXION IN THE PALACE OF TIBERIUS, PALATINE HILL, ROME.

At any moment a force of soldiers could be concentrated at any point of danger.

It is not surprising that the soldiers for diversion used to scratch lines and drawings on the rough plaster of the wall. The "graffito" of the Crucifixion is very crude, as is so often the case in sketches of this kind. It is believed that the picture was drawn by a soldier who took a more or less active part in the Crucifixion on Mount Calvary. The figures are about fifteen centimeters high. At the right and left are crosses, and soldiers mount ladders placed against them. Each person in the great tragedy is duly inscribed with his name, and "Filetus" was undoubtedly intended for Pontius

DRAWING AND INSCRIPTION SHOWING THE CRUCIFIXION.

Pilate. The inscription of twelve or fifteen lines begins with the word "Crestus," which is already known as a rough form of the name of Christ. There is considerable doubt as to the meaning of the rest of the inscription. M. Marucchi deciphers part of it: "*Crestus, virgis caesus decretus mori, super palum vivus fixus est,*" which is to say, "Christ, after having been beaten with rods, having been condemned to die, has been attached living to the cross." Various interpretations have been made of other parts of it, some of the lines being love verses. It was, however, quite customary to add to or subtract from such inscriptions; so this objection of archæologists does not militate against the theory that the picture really represents the Crucifixon. Some contend that Prof. Marucchi is mistaken, and that the scene represents a ropewalk, but what object would Roman soldiers have in portraying a ropewalk, and how does this do away with "Crestus" and Filetus? M. Marucchi makes a great point in showing that behind the central figure there seems to have been a third cross, for it is still possible to distinguish a third ladder running up the same height as the others and also a third rope hanging downward like the rest. Other professors say that the "graffito" represents the preparations for a battle. All doubts will probably be set at rest when Prof. Marucchi publishes a pamphlet upon the subject. This pamphlet is in preparation. The "graffito" is carefully protected by a grating, and it is probable that the study of it may bring some new details to light, but at the present time the evidence points to its being an early representation of the Crucifixion. For our engravings we are indebted to L'Illustrazione Italiana.

JESUP EXPEDITION COLLECTIONS.

AN exhibition of the collections of the Jesup North Pacific expedition, made during the summer and fall of 1897, will be opened in the American Museum of Natural History.

The plan of the Jesup North Pacific expedition is a most comprehensive one, and of fundamental importance for the study of the relations of the American race to other races. It deals with one of the great questions referring to the early peopling of the inhabitable parts of our globe. At an early time all the continents were inhabited by man. In a general way each continent had produced a peculiar type of man. The American continent produced a race which differs considerably from all other races. While it is by no means quite uniform over the whole continent, it is not very likely that a member of the American race, commonly called the "American Indian," should be mistaken for a member of any other race, with the exception, perhaps, of a few of the tribes inhabiting eastern Siberia. Nevertheless, the Indians show quite considerable differences in the various parts of our continent. We find tall people and people of almost diminutive size. We find people almost as light as Europeans and others almost as dark as African tribes. We find coarse and straight black hair, and also some curly brown hair. On the whole, the similarity between Americans and Asiatics becomes the greater the nearer we approach Bering Strait, where Asia and America come into close contact.

What does this similarity signify? Does it mean that the American race originated in Asia, and became differentiated from the Mongols in course of time? Did immigrants, if there were any, bring some of their culture to our continent? And do we still find its traces in the customs and beliefs of our American Indians? Or has there been later intercourse? Have there been waves of migration into our continent? Or, finally, are all these similarities so slight only that they do not signify any blood relationship or cultural relations between the peoples of the two continents? These are important questions, the answers to which will clear up the history of the American race. The great scientific importance of these questions induced Mr. Morris K. Jesup to provide the means for a thorough investigation of this subject, and the case can be answered only by a systematic investigation of the present and past populations of the North Pacific coast, because the connection, if there has been any, existed in that region.

The detailed plans for the expedition were intrusted to Dr. Franz Boas, who is in charge of the ethnological collections of the museum. He laid out the work in such a way that the North Pacific coast of Asia and America will be thoroughly examined by a number of expeditions, which are intended to extend over five years. During the past year work was carried on on the southern part of the North Pacific coast of America, more particularly in the southern interior and on the coast of British Columbia. The party which conducted

these investigations consisted of Dr. Franz Boas, Dr. Livingston Farrand, Mr. Harlan I. Smith, Mr. James Teit and Mr. George Hunt. There were two special problems to which attention was paid during the past year. On the coast of British Columbia are the remains of villages which date back to great antiquity, the refuse of these villages being piled up, in places, to a height of twenty feet or more. Since these accumulations consist to a great extent of shell, fish bones and other refuse of the kitchen, which accumulates very slowly, these deposits present great antiquity. At the present time there is a peculiar culture prevailing among all the tribes of the North Pacific coast. The first problem that was investigated was that of the development of this peculiar culture during the time represented by the deposition of these refuse heaps.

The other important question looked into was whether the personal appearance of the people changed during this period, so that one may assume that migration took place after the villages were first established.

The study of these archæological questions was taken up by Mr. Smith. Among the specimens that he obtained in his work there is one group illustrating the culture of the prehistoric people of the interior of British Columbia. Most of these were obtained at Kamloops, which is at present quite a flourishing town on the Canadian Pacific Railroad. Opposite the town a considerable Indian settlement is situated. Mr. Smith, with some difficulty, obtained the consent of the Indians to dig in the old burial places. The Indians do not know to what people these burials belong, but they do not like to see the bones of what may have been their ancestors disturbed. For this reason the chief called a council, in which the subject was very fully discussed. Finally, the confidence of the people was gained by the help of a number of photographs of the museum, in which it was shown how the people visited the halls in order to see the wonderful works of the Indians, and how they were instructed by means of lectures in regard to the meaning of all these objects, and from that time on they rather helped than resisted any endeavors to obtain collections.

The finds at Kamloops consist largely of bone and stone implements; and some of the specimens that are now on exhibition in the museum show that the art of the prehistoric people was highly developed. There are a number of beautifully carved bone clubs, the handle of one of which shows an Indian adorned with a flowing feather headdress. There are carvings representing animals; copper ornaments which were worn in the ears and in the hair, and probably also in the nose; large handmills and pestles, showing that the people gathered and dried various kinds of fruit, which were probably mixed with water, ground and boiled. The objects that were buried with the dead were wonderfully well preserved. The rainfall in this area is slight, and consequently decomposition takes place very slowly. Thus Mr. Smith found bags made of sage brush, mats made of rushes, and similar objects that had withstood the wear of time. The mode of burial of the ancient people evidently differed from the one practiced nowadays. A number of bodies had been cremated, particularly those of children, while in other cases the grave was surrounded by an inclosure made of stakes and fragments of a canoe.

The stone implements are found in great numbers scattered all over the country, and the Indians have curious beliefs concerning them. They think that they were made by the raven while he was traveling all over the world, performing great feats. They search for them, making new implements out of them. The stone implements that they were using until quite recently are of much smaller size and nicer shape than those found in the prehistoric burials. Quite a number of skeletons were exhumed, which seem to indicate that in personal appearance the past population was very much like that of the present day.

After finishing his work in the interior, Mr. Smith took up the investigation of the refuse heaps on the seacoast. The results obtained here are of great importance. The manufactured objects are only to a very slight extent chipped stone implements. The stone implements are made of slate by means of rubbing; but by far the majority of implements are made of bone and antlers. There are harpoons, arrow-heads, spear heads, etc., similar in shape to those used on the coast until recent times. But the human remains indicate that a fundamental change in the type of the people inhabiting this region has taken place. At the present time the curious custom of deforming the head prevails among the Indians. A cushion made of cedar bark is placed on the head of the infant, and tied down so firmly that it prevents the growth of the forehead. It is removed after the first year, but then the head has attained a peculiar shape, which it retains through life. For this reason the Indians are called "Flatheads." But among the people whose remains were found in the shell heaps this custom did not prevail. Their heads are nicely rounded, and seem to resemble in shape the heads found among the tribes of the interior. It seems, therefore, that Mr. Smith's archæological discoveries indicate that a wave of migration crossed the mountains and descended to the coast. It is interesting to note that this conclusion, which has been derived from the archæological investigation, is corroborated by linguistic evidence. The language that is spoken now by the tribes of the coast is akin to the language spoken in the interior, which, of course, also indicates that at an early time these people must have been closely related.

But it seems that the refuse heaps disclose a still different type of man. The people who seem to have lived here at a still earlier time were also in the habit of deforming their heads, but in a manner different from that practiced at the present time. The method of deformation which they applied is still practiced by the Indians living in the extreme north of Vancouver Island. It seems, therefore, that the archæological investigation is disclosing here very fundamental changes in the location of Indian tribes, which must have taken place many hundreds of years ago.

The other members of the party directed their attention toward the investigation of the customs and personal appearance of the Indians, with a view of determining their relationships. The exhibit shows some very interesting results of these investigations. In one case there is a series of masks collected in Bella Coola, which represent all the deities of that tribe.

The Bella Coola, from whom these specimens were collected, live on a deep fiord on the coast of British Columbia. They were visited by Drs. Boas and Farrand, who traversed the coast range on horseback, and reached the coast, descending the steep western slope of the coast mountains. On this journey Dr. Farrand visited one of the most primitive tribes of North America. They are called the Chilcotin. Until a few years ago they were a purely nomadic tribe (without any fixed habitation), while at present the larger portion of the tribe live in villages that are located on Chilcotin River. Quite a number of families, however, prefer the old roving life. Their huts are built at long intervals on the eastern slopes of the coast range, and they come into contact with the whites rarely. They live by hunting and fishing. When the salmon ascend the rivers, they come down into the valleys, and for a short time the whole tribe is assembled at certain fishing places. This is a time for festivals and amusements. But as soon as a sufficient supply of fish has been laid in, the families scatter again, each going to its favorite hunting ground. The reputation of this tribe among the whites is very bad, a great many murders having been committed until recent years. Their possessions are very scanty, and consequently no extensive collection was brought back, with the exception of a number of very primitive implements used for fishing and gathering food, and a few blankets woven of strips of rabbit skin and of lynx skin.

The expedition was very successful in collecting casts of the faces of the Indians, which represent quite exhaustively the different types of man inhabiting British Columbia. From these casts and accompanying photographs busts are being made, a few of which are on exhibition now, which illustrate the personal appearance of these Indians. The party found it rather difficult to induce the Indians to submit to this somewhat disagreeable operation; but the argument that the great chiefs in the East were not able to visit the Indians themselves, and were desirous of seeing them face to face, prevailed.

Another collection of great interest was made near the northern part of Vancouver Island, partly by Dr. Boas and partly by Dr. Farrand. It illustrates the industries, arts and ceremonials of the tribes of that region. The collection embraces a series of beautifully carved masks, which are worn in ceremonial dances, and represent the spirits which are believed to be the protectors of the Indians. Other groups of masks represent the ancestors of families, and are worn in the feasts given by the chiefs.

Besides these collections, the party brought back a vast amount of scientific information bearing upon the customs, beliefs and languages of these tribes. Much of this is embodied in the descriptive labels of the specimens, but the greater part will be elaborated later on and, when completed and published, will be an important contribution to the problems that the expedition is trying to solve. It is a matter of congratulation that the liberality of Mr. Jesup has made it possible to investigate the tribes of this interesting region before they are swept away by contact with civilization.—New York Evening Post.

THE EMPEROR OF ANNAM AS A BICYCLIST.

THE EMPEROR OF ANNAM AS A BICYCLIST.

Thanh Thai, the young Emperor of Annam, recently paid a visit to Saigon, the capital of French Indo-China, where a series of brilliant entertainments was given in his honor, as well as in that of the King of Cambodia, who was a guest of the French authorities at the same time. The accompanying figure, reproduced from a photograph by L'Illustration, represents the young emperor in the act of mounting a bicycle and shows that his majesty is not an enemy of European civilization.

THE AMERICAN EXPLORATION OF CORINTH.

The latest exploration undertaken by the American scholars bids fair to eclipse all their previous achievements in Greece. Not only is the vast site of ancient Corinth of exceptional interest and of great archæological promise, but the work is, fortunately, in the hands of Prof. Richardson, the present director of the school, who, as shown more than once in these articles, has given proof of sound scholarship and of that scrupulousness in research which is an essential in all scientific work. . . . In default of any fixed point, save the columns of the temple, Prof. Richardson decided to dig trenches in its vicinity and in other promising spots, in the hope of lighting upon one of the buildings mentioned by Pausanias; otherwise, it was groping in the dark. Altogether twenty-one such trenches were sunk, most of them with lateral openings, and all about three meters wide and from four to seven deep. The first trench, though it supplied no certain indication, revealed thirty-one Ionic columns and parts of columns used as foundations for later buildings. In the second trench, thirteen rock-cut graves were found, with a considerable quantity of common red ware. The third trench was more encouraging in its results, since it laid bare a broad paved way of fine workmanship, with water channels on either side of it—evidently one of the streets of the ancient city, leading, as is conjectured from traces met with in other trenches, to the agora. The most important discovery, and the one which decided the value of the exploration, was made toward the end of the season, when, on May 19, after a whole week's fruitless digging in trench No. 18, a succession of stones appeared arranged stepwise. On the trench being laterally extended, these proved to be the remains of the theater. Five flights of steps, innumerable seat foundations and two seats in situ left no doubt as to the significance of the discovery.

These remains are much shattered and damaged; and the steps, in some cases, are deeply worn by footprints. The interest in this fortunate find was heightened when it became evident that a later Roman theater had been built on the remains of the old structure.

A reliable starting point was thus established, and, from its position relative to the seven Doric columns, Prof. Richardson supposes the latter to be the Temple of Apollo. Beyond this temple, to the east, another trench brought to light a magnificent stoa, or passage, which also is believed to lead to the agora—the great center of the city and of its chief edifices.

The minor finds of this season's work comprise a considerable number of sculptured fragments, four heads of statues, and a Dionysiac group in marble, about half life size, representing Dionysius between Pan and a nymph. Some inscriptions, mostly Roman, four of them being practically entire, a large quantity of terra cotta fragments and nineteen whole vases, found in a cluster of prehistoric tombs—which in themselves are of great archæological interest—complete the list.

The complete, thorough and systematic excavations of Corinth will be an achievement surpassing even that of Olympia in point of historic interest, archæological and artistic importance, and in the number and value of the finds that may be reasonably expected from it. Brilliant as the work of the young American school has been thus far, an opportunity for even greater distinction now lies before it at Corinth. Prof. B. I. Wheeler thinks it will be "altogether the most important contribution made by any American excavation to archæological and topographical knowledge."

The people of Greece cheerfully give every facility, while the Greek government is again ready, in the case of Corinth, as Prof. Richardson affirms, "to buy for us just as much or just as little land as we desire, paying

a percentage of the price." But much is needed beyond this. To lay bare the entire site—not in a haphazard manner, incompatible with the requirements of science and injurious to the repute of the workers—several seasons of labor will be necessary, and a large sum of money required.

Which American Crœsus will earn for himself a fame more enviable than that of the Crœsus of old, by supplying the necessary funds for a work noble in itself and promising him lasting renown? The erection of no institution, the endowment of no foundation at home, can compare in object and result with this exploration of Corinth by the American school at Athens. It will be a service rendered to every branch of science; it will be an achievement known to and discussed by the whole world, it will be the resuscitation of the lumen totius Græciæ. The name of the Mæcenas who confers this benefit on science and civilization will ever remain connected with the imperishable fame of Corinth; while his munificence will add to the honor and prestige of America.—J. Gennadius, in The Forum.

AN INTERESTING MONSTER.

By CHARLES STEWART, F.R.S., in The Lancet.

THROUGH the kindness of Mr. Peter Taylor, of Manchester, I have had an opportunity of examining the

FIG. 1.

THE ANIMAL WHEN ALIVE.

anatomy of an interesting case of polymelian canine monstrosity. The malformation affects the posterior part of the alimentary canal and the genito-urinary organs of the right side.

The alimentary canal is normal to a point 210 mm. from the anus; the small intestine here bifurcates, both divisions having an ileo-cæcal valve at 30 mm. from the point of bifurcation. The large intestine and cæcum of the left side are normal; the large intestine of the right is nearly twice the diameter of the left and with a cæcum making only one turn; it terminates abruptly in a solid cord 20 mm. long that is continuous with the apex of the bladder of the parasite.

The left kidney is normal in position and with a

FIG. 2.

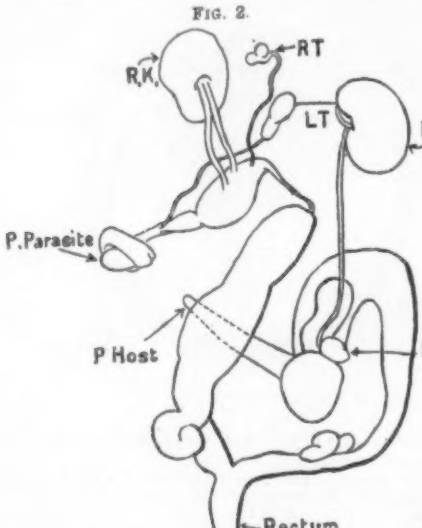


DIAGRAM REPRESENTING THE VISCERA OF THE MONSTER.

R. K. and L. K., right and left kidney respectively; R. T. and L. T., right and left testicle respectively; P. Parasite, penis of parasite; P. Host, penis of host. One-half natural size.

ureter opening into the bladder in the usual way. The left testicle was in the canal; its vas deferens was normal. The right kidney is more rounded than the left, its posterior border being on a level with the anterior of the left. It has two ureters 34 mm. long that open close together on the right side of the small bladder of the parasite. The right testicle of the parasite is small, its duct opening into the apex of the bladder. The left is of about the same size as the single testicle (left) of the host; its duct opens into the urethra. The penis of the parasite is short and has a distinct urethral opening and os penis. There was no trace of female organs. A large artery that supplies the parasite and sends a small vessel to the right kidney is given off close to the origin of the superior mesenteric.

An ischium and ilium were present on the left side of the parasite with an acetabulum in the usual position, but on the right the ilium is alone present.

A cycle path will be constructed from Graz (Styria) to Trieste (on the Adriatic), a distance of about 125 miles. The path will be 3 feet $3\frac{1}{2}$ inches wide.—Le Chasseur Français.

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